PROCEEDINGS

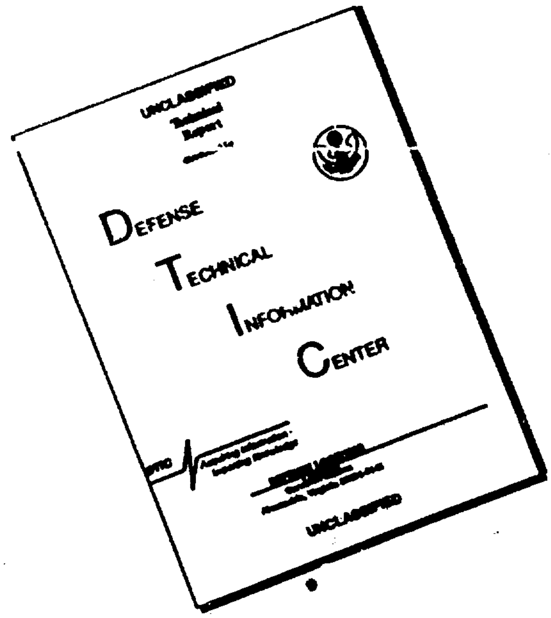
1993 ACQUISITION RESEARCH SYMPOSIUM

ACQUISITION FOR THE FUTURE: IMAGINATION, INNOVATION, AND IMPLEMENTATION

RESEARCH AND REALITY: CLOSING THE GAP

CO-HOSTED BY THE
DEFENSE SYSTEMS MANAGEMENT COLLEGE
AND THE NATIONAL CONTRACT MANAGEMENT ASSOCIATION
WASHINGTON, DC CHAPTER

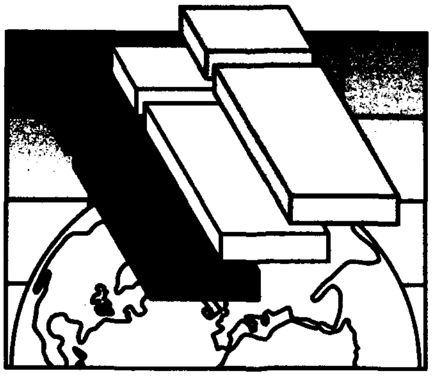
DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

1993 ACQUISITION RESEARCH SYMPOSIUM

Acquisition for the Future



Imagination, Innovation, and Implementation
Research and Reality: Closing the Gap

SYMPOSIUM HOSTS

Defense Systems Management College	Washington D.C Chapter, National Contract Management Association

DSMC CONFERENCE OFFICIALS

Mr. Calvin Brown: Conference Co-Chair
Ms. Joan Sable: Program Co-Chair

NCMA CONFERENCE OFFICIALS

Ms. Donna Ireton: Conference Co-Chair
Mr. Patrick Sullivan: Program Co-Chair
Ms. Dina Hyde: Arrangements Chair
Dr. Alma Davis: Moderator Chair
Ms. Shirley Bass: Registration Chair

*The **1993 Acquisition Research Symposium** is the latest in a series of conferences begun in 1972. These Symposia offer a dynamic forum for dialogue among key professionals working on vital issues facing the acquisition community. Attendees include senior officials, program managers, staff officers, and researchers from the Department of Defense, federal civilian agencies, academia, and industry.*

*This year's theme and subtheme reflect the future innovation and implementation in the acquisition process. **"Acquisition for the Future - Imagination, Innovation, and Implementation"** and **"Research and Reality: Closing the Gap"** are the prevailing theme and subtheme discussed and examined throughout this publication. The papers included cover the latest research and development as documented by individuals involved in the many aspects of the acquisition process.*

We invite you to take advantage of this publication, which expands upon Symposium presentations and introduces new authors and topics. Please note that the views expressed are those of the authors and do not necessarily reflect the views of the organization with which they are associated.

TABLE OF CONTENTS

AUTHOR INDEX

ACQUISITION RESEARCH

PAPERS

NATIONAL RESOURCES FOR DEFENSE RESEARCH

James W. Abellera
Defense Systems Management College

ABSTRACT

Financial resources for acquisition policy research are largely absorbed in paying salaries to people who do the research. Vast resources -- resources that do not arise from Department of Defense (DoD) funding for acquisition research organizations -- are currently available to the DoD for defense acquisition policy studies through U.S. universities.

Fiscal constraints and public-policy imperatives may require the DoD to rely more heavily on the resources of the nation's universities for acquisition policy research than it has in the past.

BACKGROUND AND THE PROBLEM

In 1989 the Defense Systems Management College started a research project called Research on Ongoing Acquisition Research (ROAR). The project sought to discover the types and extent of **ongoing** research activities conducted by professionals inside and outside the DoD on defense-related acquisition policy issues.[1] The ultimate purpose of ROAR was to create an electronic information system to satisfy two objectives.

The first objective was to enable acquisition researchers to access ROAR information freely and identify other researchers who were working simultaneously on similar acquisition issues. This would help them to accelerate their studies through mutually benefical exchanges of empirical data and ideas.

Second, DoD policymakers could use ROAR information to review ongoing acquisition studies on topics of immediate policy interest. Thus they might avert expenditures for research start-ups that would duplicate work already in progress.

Additionally, policymakers might quickly obtain useful findings from projects that were nearing completion but were not yet published or otherwise identifiable through a search of databases centrally maintained by the Defense Technical Information Center (DTIC), Defense Logistics Studies Information Exchange (DLSIE), CompuServe, government libraries, etc.

A discussion of ROAR's current status appears in Appendix 1.

ROAR began with the aim of developing abstracts of ongoing studies being performed within all relevant research communities. For example, it was known that thousands of reports related to acquisition policy are funded each year by DoD. The research underlying the reports is conducted by the DoD's own employees, by the employees of its Federally Funded Research and Development Centers (FFRDCs), and by other contractors.[2]

A review of DoD's centralized bibliographic databases yielded huge lists of published acquisition studies prepared by researchers within DoD. Within-DoD research is defined here to include studies performed by the DoD's employees, FFRDCs, and for-profit contractors. The same databases offered little evidence that similar research was performed by other groups -- by professors in universities for example -- with DoD financing or otherwise.[3]

However, an informal review at that time of articles in academic and professional journals for selected disciplines (e.g., engineering, economics, law, political science, operations research, finance, business and management, etc.) suggested that university scholars had conducted defense-related acquisition policy studies as well.

To ensure ROAR's coverage of acquisition studies would not overlook possible major producers of such work, the decision was made to pursue information about ongoing research projects at universities and other organizations outside DoD (e.g., non-profits without affiliation with the DoD and trade associations) as vigorously as within-DoD project information.

The source of funding for within-DoD research was evident: the Defense Department provided most or all of the funds. But if many ongoing projects in defense acquisition policy were found to exist at universities, it would be interesting to determine their funding sources. Three different sources of funding for such projects seemed possible.

First, it was possible that the DoD provided direct funding for many university efforts. But in this case, the mechanisms for including descriptions of the research in the DoD's centralized bibliographic databases were evidentally imperfect.

The second possibility was that private corporations, non-DoD federal agencies, and foundations provided universities with direct funding for some university research. In this case, the DoD's centralized databases would not normally capture information about these studies.

The third possibility was that universities effectively funded some of the research themselves. Professors are normally paid by their university to conduct research of their choosing as well as to teach. It would be understandable for professors in many disciplines to undertake original research on issues in defense-related acquisition policy to demonstrate their disciplines' capacity to illuminate key public-policy issues and options.

HYPOTHESIS

It was hypothesized that at least 25% of all university projects discovered by ROAR would prove to be funded directly by the Department of Defense. In developing the hypothesis, it was assumed that the particular method chosen to elicit ongoing research descriptions, including sponsors' identities, would lead

naturally to a high incidence of DoD sponsorship reported in the research performed in universities. The true incidence was hypothesized to be somewhat less than 25% in the population, but it was believed that an unbiased estimate would not be obtainable using the elicitation method.

The elicitation method involved chaining through telephone interviews with direct referrals. Initially, five DoD researchers would be contacted individually. They would be asked to describe their ongoing research, if any, dealing with defense acquisition policy. At the conclusion of the interview, they would be asked to identify anyone else currently conducting defense acquisition research, regardless of whether it was related to their work or not. The referrals would then be contacted, interviews would be repeated, new referrals would be sought, and so on.

It was assumed that within-DoD researchers would tend to be aware of other projects in progress that were financed by the DoD and less aware of those not financed by the DoD. The reason: the easiest way to learn about ongoing work prior to its publication is through direct personal contacts; and such contacts occur more often between a within-DoD analyst and his or her co-workers employed in the same facility than between a within-DoD analyst and university scholars.

It was further assumed that, when an interview with a DoD researcher did produce a referral to a university scholar conducting acquisition research, the referral would tend to be based on the fact that the university effort was funded or otherwise sponsored by the DoD organization from which the referral came. At least, insofar as the organization actively funded/sponsored **any** projects in universities, this was thought to be a likely outcome.

In short, it was assumed that chained interviews to elicit descriptions of ongoing acquisition policy research, commencing with within-DoD researchers and their personal referrals, would bias upward the reported incidence of DoD funding for the university research projects that were discovered. Such a bias would lead to the discovery of at least one university project directly funded/sponsored by DoD for every three reported to be funded in some other way. This was the hypothesis tested by the ROAR project.

FINDINGS AND DISCUSSION

Interviews with researchers began in December 1989 and continue today. In November 1991 a preliminary analysis was done based on interview data for ongoing acquisition policy studies conducted by university scholars. Those data showed that 5% of university projects had been financed or otherwise sponsored by DoD.[4] Subsequent analysis of data for ongoing studies collected as of November 1992 yielded the same 5% figure.

The data shown below summarize the results of the 1992 analysis. Because the finding of 5% incidence is unchanged from the 1991 analysis, this paper presents results based on

the more recent data, as of late 1992.

Ongoing Projects in ROAR

	Univ Proj	All Proj
Total Number:	370	876
Total funded /supported by DoD:	19	504

These data show that 5.1% (19 of 370) university projects, or about one in twenty projects discovered through chained interviews, were directly funded/supported by the Defense Department. The 5.1% estimate for the sample proportion is *significantly different from* the hypothesized 25% proportion at the 0.01 level.

It is possible that some researchers simply avoided reporting DoD support for their work for unknown reasons. However, each was told that DoD policymakers would have access to their descriptions. Thus it is unlikely that many would risk having their DoD sponsors learn they had misrepresented the fact of their sponsorship.

Among the 19 DoD-sponsored studies, the most frequently cited sponsor was the Office of Program Analysis and Evaluation (PA&E), within the Office of the Secretary of Defense. In the late 1980s, PA&E initiated support for university research in economics and other disciplines to address defense acquisition-related issues. The RAND Corporation administered the projects on behalf of PA&E.[5] Other university studies funded by DoD reported various Army, Navy and Air Force sponsors.

The 1992 analysis showed that a total of 89 of the 370 university projects, or more than a fifth, enjoyed external sponsorship. In addition to the 19 DoD-sponsored efforts already noted, 70 projects were variously supported by private foundations (e.g., Pew Charitable Trust, Bradley Foundation, Olin Foundation, Twentieth Century Fund), corporations (e.g., Unisys, IBM, Hughes, Boeing, General Electric), non-DoD federal sources (e.g., National Science Foundation, Department of Commerce, NASA, FAA), and a wide range of professional and trade associations.

It is noteworthy that university research represented more than 40% of all defense acquisition policy studies discovered by ROAR interviews. And more than three-quarters of the university projects (281 out of 370) were apparently begun at the initiative of professors and fellows with direct funding from their universities.

Another significant result of the data-collection effort concerns the observed pattern of referrals through interviews. Although statistics were not maintained to characterize the pattern, a finding based on non-empirical observation helps to explain why the hypothesized incidence of 25% for DoD sponsorship of university projects was not confirmed with actual data. This finding also may hold important policy implications for future defense

acquisition research.

Bridging Separate Communities.

The previously stated assumption that within-DoD researchers would tend to offer referrals to other DoD researchers was confirmed. Of course, DoD researchers occasionally volunteered the names of university researchers as well.

When these university researchers were contacted, they rarely indicated knowledge of ongoing activities within the DoD research community (although many said they were interested in learning more). In turn, their referrals tended to include other university researchers with whom they were familiar.

By mid-1990, the interview process had divided with unexpected clarity into two tracks. One track produced chained interviews about within-DoD research underway, with referrals to like researchers. The other track generated interviews with university scholars about their studies, with referrals mainly to other university researchers.

ROAR's interviewers found they could provide a valuable informal service, where possible, by alerting one researcher to the efforts of another researcher who had been interviewed previously -- based on the interviewer's recollection that the two were studying a common issue. But as the aggregation of projects rose to many hundreds, it became difficult to continue the service with human interviewers who, lacking eidetic memories, could not instantly recall the details of every prior ROAR interview. However, the revealed need for the cross-dissemination of pertinent ongoing-research descriptions was specifically addressed in developing ROAR's electronic information system.

If the incidence of DoD-sponsored university research had been estimated in mid-1990 (with six months of data), it is possible that a figure higher than 5% would have resulted. However, it appears that the collection of data along two tracks simultaneously for a period of years obscured the effect of choosing only within-DoD researchers to commence the interviews.

The collection of data by interviews continues today on both tracks. The rate of progress indicates that the projects already reported to ROAR represent small fractions of all ongoing studies in DoD-funded organizations and in the university research community.

The 1992 findings support the view that universities are conducting a large number of research projects on defense acquisition policy; and few of the projects appear to rely directly on Defense Department resources.[6]

Additional Findings: Types of University Projects.

It may be useful to know how university acquisition research projects in progress vary in broad type from all other projects (mainly within-DoD projects) captured by ROAR. To observe differences, twelve

categories of defense acquisition policy research were established.

All 876 ROAR projects were classified by broad acquisition category. The classification procedure allowed each project to be classified as belonging to at least one and no more than four categories, depending on the relevance of the research to the respective categories. This procedure recognized that a given study, say a project concerning new defense contracting rules for acquiring commercial items, would be properly classified as relevant to two of the categories: Commercial Products & Practices; and Contracting & Subcontracting Issues. Rarely was a project found to "belong" to as many as four categories.

The results of the classification procedure appear below as percentage distributions of university research projects among all ROAR projects within each of the twelve broad acquisition categories. The categories are arrayed from the category for which the incidence of university projects was highest to the category of lowest incidence. No prior assumptions were made about the data distribution within categories. The average incidence of 370 university projects among all 876 ROAR projects was 42%.

<u>Commercial Products & Practices</u>

Tot Proj	Univ Proj	Incidence
113	61	54%

<u>Defense Acquisition & the Political Process</u>

Tot Proj	Univ Proj	Incidence
101	53	52%

<u>Engineering & Manufacturing Matters</u>

Tot Proj	Univ Proj	Incidence
125	65	52%

<u>International Acquisition Issues</u>

Tot Proj	Univ Proj	Incidence
89	45	51%

<u>Defense Industrial Base</u>

Tot Proj	Univ Proj	Incidence
196	91	46%

<u>Logistics Approaches & Issues</u>

Tot Proj	Univ Proj	Incidence
229	100	44%

<u>Contracting & Subcontracting Issues</u>

Tot Proj	Univ Proj	Incidence
213	93	44%

<u>Acquisition Management Education & Workforce</u>

Tot Proj	Univ Proj	Incidence
157	55	35%

<u>Cost & Price Considerations</u>

Tot Proj	Univ Proj	Incidence
183	59	32%

Financial Mgmt & Budget Instability

Tot Proj	Univ Proj	Incidence
90	25	28%

Program Mgmt (Decision Support) Systems

Tot Proj	Univ Proj	Incidence
269	71	26%

Streamlining Acquisition Mgmt

Tot Proj	Univ Proj	Incidence
140	32	23%

A general observation about these data is that university research projects seem to be relatively skewed toward the acquisition policy issues that are concerned with manufacturing changes to improve U.S. competitiveness; with the need to adjust to the political imperatives of reduced defense spending; and with the realignment of the defense industrial base.

The skew in research priorities might prove to be a fortunate development for universities and the nation: the current administration apparently aims to speed defense spending reductions while trying to smooth conversion of defense industry to competitive commercial pursuits.

For within-DoD research organizations, these additional findings and observations suggest important opportunities as well as potential new problems.

CONCLUSIONS AND IMPLICATIONS FOR DEFENSE ACQUISITION POLICY RESEARCH

The conclusions of this paper are that (1) universities currently conduct a large number of defense acquisition policy studies; (2) they have not depended directly on defense funds for most of their work; (3) the DoD-funded acquisition research community is not well aware of university efforts in progress, and vice versa; and (4) many university researchers may have anticipated the types of acquisition research efforts needed to support key U.S. policy trends in the 1990s.

In view of proposed DoD budget reductions in coming years, it seems likely that DoD-funded research organizations will be competing vigorously with all other DoD activities for declining resources.

But ROAR's survey of ongoing studies suggests that vast resources for defense acquisition policy research exist in universities, where they are not subject to the same budget forces as the DoD faces. Moreover, there is tentative evidence that the DoD, Commerce Department, and National Science Foundation plan to augment these resources with new funding for additional acquisition-related projects to be performed by universities and other agents outside the Defense Department.[7]

These portents commend a shift in operating style for DoD-funded acquisition research organizations, toward a strategy that might be called wide-area research management.

Wide-area research management recognizes that some DoD organizations will not continue to employ as many researchers as they do now. If resources for research remain abundant outside the DoD, then defense institutes, schools, and centers may organize themselves so that they become authorities on the current state of acquisition studies everywhere -- especially in universities.

By attaining unmatched expertise, these organizations will be positioned to guide policymakers in allocating scarce DoD research funds effectively, often including the direction of department funding to researchers outside the traditional defense fold to satisfy DoD needs.

Soon, for example, fewer defense organizations may be able to say, "We just received a vital new acquisition priority plus a million in DoD money; let's get a few analysts downstairs started on it for a year." Instead, a successful organization may be one that can quickly find those campuses where professors are already working on a related problem, can persuade the scholars to focus additionally on DoD's specific priority for $50,000, and then will work with them to get the results out in months.

If defense research organizations decide to specialize in wide-area research management, they will need to know much more about the research activities of the nation's universities than they do today.

There will be perils in fitting non-DoD resources to DoD research priorities. But there are also perils in operating in ways that fail to fit defense resources.

FOOTNOTES

1. Defense acquisition policies delineate between acceptable and unacceptable management practices for controlling how the DoD acquires goods and services. Defense acquisition policy research is defined here as research that improves understanding about effective practices at various levels of control and also about internal and external circumstances that can cause the DoD to change its policies. Some policies describe practices that are unique to DoD. Others deal with practices that are commonly used in less-tightly regulated organizations such as companies and non-DoD government agencies.

2. Part of the annual publications output is currently reported in Defense Logistics Studies Information Exchange, 1993 Annual Department of Defense Bibliography of Logistics Studies and Related Documents, Department of Defense, 1993, pp. 1-663. The volume lists over 1400 titles produced by or for DoD each year. Although less than half of the logistics-related reports listed are considered by the author to involve acquisition policy research, logistics concerns form only one of many areas germane to acquisition policy.

3. Ibid., pp. 664-661. For example, 23 logistics-related projects were performed by universities out of 2,805 total

projects completed and published with DoD funding during a two-year period. Also, the IDA (Institute for Defense Analyses) Cost Research Symposium began an innovative program in the early 1980s to identify and disseminate news about ongoing research on cost-estimating models and other cost issues in DoD acquisition. In 1989 IDA reported 209 projects to the Symposium's within-DoD participants. No university research was included; all reported projects in 1989 were performed by within-DoD organizations. See S.J. Balut and K.L. Wilson, "The IDA Cost Research Symposium," Institute for Defense Analyses, IDA Document D-647, August 1989, various pages.

4. Levels of DoD funding for university projects were not discovered during the interviews. Some forms of support may have included sharing of DoD empirical data and privileged access to records and\or facilities rather than direct funding for the projects.

5. The PA&E initiative has begun yielding acquisition policy research publications by university scholars. Some studies are authored by professors and published by RAND. For example, see Rogerson, W.P., "An Economic Framework for Analyzing DoD Profit Policy," The RAND Corporation, R-3860, 1992; and Rogerson, W.P., "Overhead Allocation and Incentives for Cost Minimization in Defense Procurement," The RAND Corporation, R-4013, 1992. Rogerson is professor of economics at Northwestern University.

6. It is possible that some research projects benefit from university facilities and staff that are funded by non-acquisition DoD organizations. For example, the DoD funds university research in basic and applied sciences through offices such as the Advanced Research Projects Agency, the Office of Naval Research, and the Air Force Office of Scientific Research. But it is not apparent that these DoD resources contribute even indirectly to the financing of university acquisition research.

7. For example, DoD's Advanced Research Projects Agency (ARPA) will manage $472 million in 1993 for acquisition-related research, technology development, training, and education through its new Technology Information Project. Universities are eligible to receive up to $356 million of the total figure (and one-half of the $356 million is reserved exclusively for universities). DoD's internal research facilities are eligible to receive no more than $91 million of the total, and they must compete for these funds against other government agencies, universities, for-profit firms, and non-profit organizations that are also eligible. See Technology Information Project, "Program Information Package for Defense Technology Conversion, Reinvestment, and Transition Assistance," Advanced Research Projects Agency, Department of Defense, March 10, 1993, various pages. ARPA is a DoD research organization with decades of experience in successful "wide-area management" of university research in basic and applied sciences to meet defense priorities.

APPENDIX 1

CURRENT STATUS OF THE **ROAR** ELECTRONIC INFORMATION SYSTEM

Rollout of DSMC's Research on Ongoing Research (ROAR) System

In the fall of 1992 the Defense Systems Management College (DSMC) completed the development and testing of ROAR's electronic information system. On October 19, 1992, the system was opened to acquisition researchers working at 42 institutions where 400 ongoing projects in defense acquisition policy research had previously been identified by ROAR interviews.

By mid-1993, ROAR will be open to all researchers, including those in over 200 institutions, both within-DoD and at universities, where more than 1,000 acquisition studies are known to be underway.

User Access to ROAR

Anyone can access the ROAR system by calling a commercial telephone number using a computer and modem, plus any standard communications software program (e.g. Procomm, CrossTalk, etc.). ROAR's phone number and communications settings are as follows:

Phone No.: (703) 805-3981

Baud rate: 2400-1200
Data bits: 8
Parity: N
Stop bits: 1

If the caller has not previously registered an abstract of ongoing acquisition policy research, ROAR explains how to "download" basic instructions that provide an overview of ROAR's services plus directions on how to register an abstract of ongoing research.

When the user has read the instructions and is ready to register an abstract of ongoing research, he or she calls ROAR again. Then the user creates a unique ID, types in basic descriptive information (name, organization, phone number, etc.) and enters an abstract of the research project in normal English words and sentences. Finally, the user is instructed to log-off (terminate the phone connection) and call back 48 hours later.

By the time the user calls back, an electronic "mailbox" will exist for the user's unique ID. After logging-on, instructions appear that explain how the user can download the contents of the mailbox to his or her computer. The mailbox contains a copy of the user's

own abstract, search results (the ten abstracts in ROAR's database that most closely match the project that the user registered), and further directions.

The directions (which the user prints out after downloading the mailbox contents from ROAR and logging-off) explain that ROAR will conduct additional searches against the user's abstract after ROAR has received by postal mail the user's signed statement certifying that the registration data, with changes marked clearly, are accurate in all respects.

As soon as ROAR receives the certified registration, the database is searched again. The results (the next ten abstracts that most closely match the user's project description) are loaded in the user's mailbox.

ROAR's Weekly Service for Researchers

After the user has downloaded these additional search results, ROAR begins its **weekly** service to the user. Every Monday morning, the user's mailbox is loaded with one new abstract that has not been presented before. The abstract is generated by a weekend search of the entire database for the next most-closely-matching project description.

Since ROAR acquires abstracts continuously, the weekly service means ROAR can keep informing its users-researchers individually about the latest relevant ongoing work throughout the active life of their research projects. It does this automatically without requiring each user-researcher to repeat the registration process.

The key to the weekly service is ROAR's searching methods. Searching is based on the user's registered abstract, and the work is done off-line by ROAR's computer programs. The user can call ROAR once a week (at his or her convenience) to download the search results. Each user spends less than one minute (the time spent logging on, downloading, and ending the call) to stay informed about all relevant new research underway.

ROAR's active users report that these services are enabling them to discover relevant ongoing studies about which they might otherwise know nothing. Users decide for themselves whether they want to act on their discoveries by calling one another to exchange ideas and data.

The ROAR electronic system is open to the public every weekday from 6:00 a.m. to 2:00 p.m. and 3:00 p.m to 11:00 p.m., eastern time.

Individuals can also register new projects by calling ROAR's contract staff in person (voice only) at (703) 271-5988, Mon-Fri, and answering questions about their project. However, ROAR database search results are available only by downloading with use of a computer and modem. The FJV Company is ROAR's contractor.

THE UNCERTAIN VALIDITY OF RESEARCH RESULTS

by
Henry C. Alberts
Defense Systems Management College, Fort Belvoir, Virginia

ABSTRACT

One major difference between the physical and social sciences is the way in which investigative boundaries can be selected. In physics and mathematics, one can isolate particular events and study them with the assurance that results observed are likely to be repeatable. In the social sciences, boundary selection might be dictated by factors other than experimental convenience, or even the possibility of achieving experimental validity; and the results obtained may be neither repeatable nor reproducible across time and space. It is specifically these issues of boundary setting and result variability that create both the richness for inquiry and the challenges to understanding of exactly what has been learned. This paper presents some hypotheses about the conditions under which social systems, and complex engineering systems might be better investigated.

THE BEGINNING BOUNDARIES

A fundamental principle of what has become known as "science" is the ability to reproduce results across time and space. One of the factors which influenced my choice of physics and mathematics as subjects of study was that assurance of result reproducibility - one could come to know the "right" answer to properly posed questions.

As first an experimental, and then theoretical physicist and mathematician, I was delighted to find that properly constructed experiments would transfer to other locations. The work I was doing in supersonic aerodynamics in 1949 could be checked using results produced by others with similar equipment in other places. In those days, meetings of the American Physical Society were places where those of us working on the same problems could get together and compare experimental results. Because results were the same (*to within what we knew to be experimental error*) we reassured ourselves about the "correctness" of our knowledge; and validated our work.

From time to time, someone would report on a result no one had obtained before. In almost every case, the experimenter had changed the regime (the boundaries) in which prior work had been done. For example: in the early 1950's a few of us were exploring the physics of supersonic flow. Wind tunnels, which were the standard test environment for aerodynamic testing, had severe limitations for such work. Attempts to create supersonic wind speeds had resulted in damage to the fans and propeller mechanisms which produced the air flow; and to the tunnel walls. The requirement to pass through a turbulent trans-sonic regime damaged the propellers, and the heat generated down stream from them stressed both the tunnel wall material and the instrumentation we could build at that time. The invention of the "Shock Tube" at Johns Hopkins University Applied Physics Laboratory provided a means to study supersonic flow without generating those problems.

The idea of the shock tube was to create a "period of supersonic flow", a transient rather than an extended time event. Because the creation of the burst of flow was instantaneous and only lasted a few milliseconds, the problems of experimental equipment construction and instrumentation became tractable. A shock tube consisted of two chambers isolated from one another by a piece of material called a diaphragm. One chamber was maintained at normal room temperatures and pressures and air was free to flow through it. The second chamber (the enclosed space) contained gas under high compression. The diaphragm maintained the separate integrity of both compartments. When the diaphragm was pierced, the compressed gas would press outward from its restricted chamber, bend back the diaphragm, and pass into the second chamber. Since gases are compressible fluids, it took some time for conditions in both portions of the tube to stabilize at room conditions. As the gas under high pressure entered the tube, it formed a "shock front" (or wave) behind which supersonic flow occurred. Figure 1 presents a typical shock wave and indicates the regions of supersonic and transonic flows.

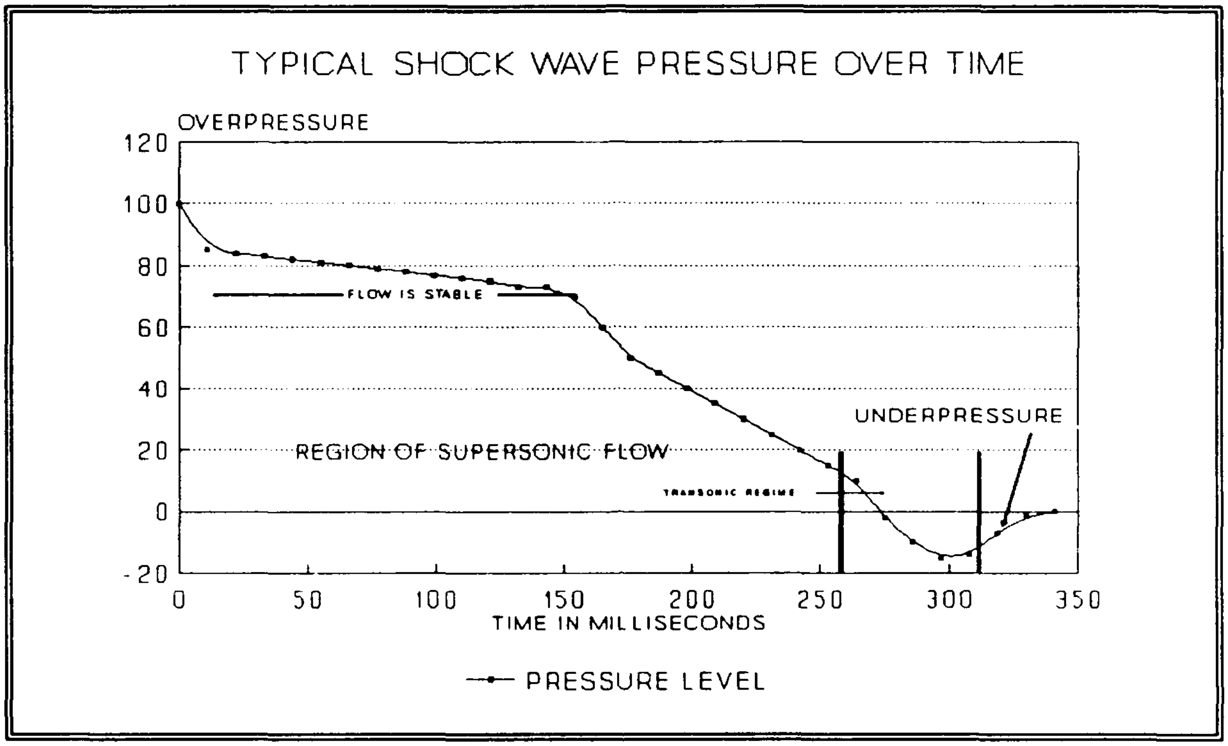


FIGURE 1

Of course, heat was still produced, but it was of such short duration that none of the system components, the shock tube material, the instrumentation, or the models we used were damaged.

Moreover, although our supersonic regime lasted for only very short periods, what we learned was truly representative of supersonic flow. The reason was because the time required to respond to the impulse behind the shock front and establish stable supersonic flow around the model was quite short compared to the time the supersonic regime lasted. That is to say: the response times of the solid material and the fluids to the shock wave and its associated flow were different enough to permit studies of the supersonic flow phenomena. Those studies yielded crucial information about the conditions to which bodies returning from space orbits would be subjected.

At one meeting of the Physical Society, Arthur Kantrowitz reported results from shock tube experiments which differed significantly from what we had come to believe was "the norm". His contribution was to change the boundaries of the experimentalSystem. He pre-heated his compressed gas beyond the normal temperatures caused by gas compression; and he changed the gas as well. As a result, the temperatures behind the shock front were highly elevated. Under these conditions, although the models remained the same, there were differences in the flow patterns because the gas became ionized. Many of us were fascinated by Kantrowitz's results especially because ionization and molecular dissociation could very easily explain small differences in flow patterns we had already observed and categorized as being part of the "system experimental error".

But the most interesting thing about all of this was that when real re-entry bodies were tested, those test results verified the laboratory results: The flow patterns around re-entering vehicles *were* like those obtained in shock tube experiments *until the temperature built up in the mid-level re-entry*. At mid level, the atmosphere ionized around the vehicle leading to what we came to call "communications blackout": a situation marked by inability to send electromagnetic signals through the atmosphere because it simply reflected from the ionized layer which surrounded the incoming vehicle. This phenomena corresponded to the well-known communications phenomena which had become known as "ionospheric scatter": radio waves would reflect off the ionized layers of the earth's atmosphere. Ionospheric scatter communication systems used this effect to achieve long range high-frequency radio communications.

There are many more instances in physics and engineering within my own 45 years of experience which demonstrate consistently that changes in experimental system boundaries cause results which differ from previously accepted norms.[1] The point of this discussion is to lay a basis for the assertion that:

> When measuring the behavior of what we call "stable" entities under changing environmental conditions, not only should changes to behavior be expected, but one should also anticipate change to the entities under study. That is; data obtained by repeating the same set of experiments within even slightly changed "experimental systems" can yield very different and sometimes unpredictable results!

THE MIDDLE LEVEL BOUNDARIES

Physicists try to establish tight control over experimental systems and their boundaries. That can be done in many cases because physical environments and equipment do not "learn" or "change" of their own volition while undergoing physical experimentation. Social Science experimentation is a considerably different thing.

I began to work with large, integrated systems in 1953. Initially my work with Ballistic Missile and Space programs was in the aerodynamic design area. But incipient success quickly led us to problems in the system's operational use and logistics planning. It became necessary to know how inaccuracies in our knowledge of where targets were located interacted with uncertainties about distances between continents and errors caused by imperfect system performance to produce errors in missile impact locations. Continuing questions about system performance led to experimental testing of weapon effectiveness when different weapon mixes were employed by differing groups of human beings acting either as individuals or within coordinated organizations.[2]

By the late 1950's and early 1960's, there was considerable interest in developing combat tactics for small groups of soldiers operating in a guerilla environment. It was that particular work which provided the first structured insights into problems of experimental data reproducibility when human beings were involved.

Considerable amounts of this sort of work were done at the Army's Combat Development Experimentation Center (CDEC) at Fort Hunter-Liggett and Fort Ord in Central California. The Army established CDEC in 1958 as a place to develop new tactics and

doctrines which made best use of newly developing weapon systems. One of the ways we did experiments to arrive at suggested force structural change was to devise and repeat exercises which would produce statistically rigorous results. We would repeat portions of these exercises using different groups of people: a process we referred to as "replication".[3] When we had developed enough data, our analysis would provide performance "norms" which were then used to design tactics.

We had some problems with that approach. Sometimes the results of a carefully designed "set-piece" of action performed by one group differed so much from the results obtained from other groups that we had to exclude one or more result sets from the complete set of trial data. Our usual justification was that "something had gone amiss during that particular run"; and the data from that run was "rogue data", "outside the norm".[4]

We also discovered that when we asked groups of soldiers to do a set of activities, in different sequences, the results would very often differ by more than we anticipated. That is, if we designed an experiment consisting of five tasks which could be performed in any order, and we set about collecting performance data for each of them, we found that task performance results tended to vary depending on task performance sequence. To state this point another way;

If a Task Sequence of 1, 2, 3, 4, 5 yielded results: $1_1, 2_1, 3_1, 4_1, 5_1$;

and Task Sequence of 2, 5, 4, 1, 3 yielded results: $1_2, 2_2, 3_2, 4_2, 5_2$;

and Task Sequence of 1, 5, 2, 4, 3 yielded results: $1_3, 2_3, 3_3, 4_3, 5_3$

we found that for each task,

$$(1_1, 1_2, 1_3; \ldots 5_3, 5_3, 5_3)$$

performance varied so widely that simple statistical treatment was inappropriate. *We had observed non-reproducibility!*

Clearly, how people performed tasks differed depending upon the sequence of task performance: they "learned" something by performing a task which affected how they performed succeeding tasks.[5] Thus, in order to define performance in a way that would be reproducible across time and space, a matrix array of tasks and trials would need sufficient entries in each cell to insure that the effects of task sequence on result obtained was known and could be accounted for.

A five task matrix array shown below indicates some variable task order choices. The objective of the task sequencing is to have tasks performed in differing orders and to permit two instances when task orders followed each other in sequence.[6]

FIVE TASKS TAKEN IN VARIED SEQUENCE WITHIN 5 TRIALS

TASK #	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4	TRIAL 5
1	1st	2nd	3rd	4th	5th
2	2nd	5th	1st	3rd	4th
3	3rd	1st	4th	5th	3rd
4	4th	3rd	5th	2nd	2nd
5	5th	4th	2nd	1st	1st

To get high assurance of statistical validity of results obtained would require performance of a great many trials. In fact, many complex task sequences would require more players and tests than could be practically realized.

In 1965 I became interested in whether this problem of result non-repeatability was unique to our particular application[7] or applied in general to complex systems. To find out, I did some research for the U.S. Commissioner of Education[8] on the "Conditions of Learning". The problem was to construct an experimental program to determine how conditions within the classroom affected learning. We would measure learning by administering an objective knowledge or skill test.

A literature review quickly provided more than a thousand references which purported to have performed a study of how conditions under which learning occurred affected the learning outcome. As each of the reports was studied, it became clear than none of them had recognized the richness of the problem!

To treat all of the variables which might affect the learning process in a classroom, one would have to consider at least the conditions listed below:

1. The purpose for which that class was convened: General Education, Training for Specific Task Performance...
2. General Educational Institutional sponsor, Commercial Work Sponsor, Military Sponsor...
3. The kind of facility in which the class was held: Typical Public/Private School Room, Industrial Training Classroom, Military Classroom, Special Purpose Facility (which had multiple uses other than classes)...
4. The Size, Shape, Configuration, of Facilities used...
5. The methodology of instruction: Lecture, Demonstration, Discovery, Computer...
6. The kind of instructor: Subject Professional Instructor, General Professional Instructor, Expert General Practitioner, Practitioner with special experience...
7. The subject matter of instruction: fundamental categories of subject matter (mathematics, economics, psychology); some other specialized subject matter pointed at specific sets of task performance levels; or subject matter whose objective was to build conditioned responses (behavioral modification)...
8. The class demography pattern: ages and numbers of students, past learning and life performance, socioeconomic grouping, language and literature skills...

These eight major categories which we thought "had impact on the problem" turned quickly into a matrix containing over 10,000 cells when all of the detailed indentures under each of the eight categories were considered! When we tried to structure a program to derive statistically significant data, we came to believe there weren't sufficient people available to create a full data set.[9]

Even more important, we believed that any measurements we did take would change with time. The performance of each student would be affected by all the prior experiences of that student as modified by the instructional experience in the classroom. That meant that in such a complex situation, we couldn't see how to build a continually growing data base. Therefore we couldn't take a few students in each category, complete the work, and then repeat the work sequence with some other students in other categories. During the time we were performing the first experiment, the students who had not yet participated in it would be experiencing things in their lives which affected their performance when they came to the classroom later.

We had inadvertently constructed a real experiment for which available time and resources might always

be excessive! There should be no misunderstanding, the Commissioner of Education although stunned by the implications of our analysis agreed with us that as constructed, the problem was "too large to solve"! He had no suggestions for smaller studies because both he and we understood that the variabilities in results over time would very likely dominate the process and thus make any rigorous analysis extremely (perhaps too) difficult.

GREATLY EXPANDED, CROSS-CULTURAL LATER STAGE BOUNDARIES

In 1967, I was asked to serve as a management consultant to Swedish industrialists. The leading commercial bank in Scandinavia[10] was "involved" with almost every large Swedish industrial organization.[11] My task was to address losses (negative profits) being experienced by a number of the companies and to "turn those companies around" so they made a reasonable profit.

As I looked at the way business was done in the largest paper making facility in Europe, I became convinced that much of the difficulty was caused by "cultural" or "mind-set" patterns within the Swedish and European cultures. Acceptable ways of doing business were not amenable to change. In fact, one of Chief Executive Officer (CEO) refused to accept recommendations for making his company profitable because they were "counter to established Swedish cultural practice". Of course, since bankers were in charge, he was released from the company and replaced by someone who did accept those changes. The changes suggested turned the company's Fiscal Year 1967 loss of 35 million Kroner to a Fiscal Year 1968 profit of 30 million Kroner.

The lesson learned was that cross cultural influences have deep affect on both how people perform similar (perhaps even identical) tasks and the depth of their resistance to necessary change. In a seminal study, Gervaise Busche[12] found that even after extensive Total Quality Management training, and acceptance of that concept, the management in a number of American auto manufacturing plants did not want the cultural changes associated with worker empowerment. But even more important, they did not "understand why we would pay someone such a large salary to prevent problems when we haven't had any problems in a couple of years."

In 1978, I was asked to visit Sweden again to meet with the Board of Directors of Rank-Xerox in Stockholm. A friend was on the board and said he had been impressed by the work done in 1966-1968, and thought it would be instructive to hear my later perceptions of how Sweden was progressing.

I found much which surprised me. The culture had changed! What would have been unacceptable in the mid to late 1960's was, in the mid 1970's, not only acceptable but preferred. One of the most interesting changes was how income maintenance programs were conceived. From the time of their institution in the 1930's, income maintenance was provided without regard to societal contributions recipients made. Many simply remained in their state provided homes, making no effort to participate in working society. That had still been the case when I lived in Sweden from 1967-1968. But early in the 1970's the government had begun a new approach to income maintenance. Those receiving it were encouraged to open businesses and address themselves to creating some good or service. If the income derived from those businesses was less than the amount which would have been received as income maintenance, it would be augmented to insure at least the stipulated amount was received. The effect of this policy shift was to create new small businesses which rented space and involved themselves in commerce. The small entrepreneur was protected from gross economic failure, but the effect of involving previously untapped individual creative capacities greatly benefitted both to the society and the individuals; creativity flourished and many kinds of hand made goods were available in many revitalized central city market districts.

When I asked what caused the change, I was told that it came about because people recognized the need to encourage independence rather than dependence.

I thought Sweden was unique until I went to the People's Republic of China in 1983 and found the same kind of entrepreneurial encouragement program there. China had experienced a remarkable decrease in the numbers of factory jobs required to meet production quotas. Rather than make income maintenance payments with no return to the State, the government gave unemployed individuals sufficient money to set up small service businesses. Those business were "unregulated"[13] and entrepreneurs could keep much of what they made.[14] By 1985 many of those businesses had flourished and some entrepreneurs had become "millionaires" in China. Unfortunately later events contracted, and sometimes even eliminated, the entrepreneurial sectors which we had seen in Shanghai, Nanjing and Beijing in 1983.

SOME IDEAS ABOUT VALIDITY DURATIONS

I believe that as problems become more complex, their boundaries widen. That is especially true when the problems concern large systems which include human beings as crucial portions of interconnected physical systems. We have developed a number of techniques which can define envelopes of operating integrity experimentally for rather complex devices.[15] Those envelopes can be reproduced over time and across space. But we have yet to establish comparable capabilities for projecting how human learning or cultural changes that happen during the course of a complex investigation will affect investigatory results. Rather, the opposite is true: We have considerable difficulty projecting how individuals will make use of complex "systems" in complicated and changing situations. It simply isn't easy to predict accurately what humans will do when faced with changing circumstances.[16]

It seems to me that one important indication of the durability of research result validity can come from understanding the concept of "time constants of change".

In studies we performed for the Chief of Naval Operations, 10 models of the U.S. economy were examined to see how well their predictions matched actual economic change over time periods of from 3 months to up to 10 years. Actual data for 40 quarters were taken from Bureau of Labor Statistics and Federal Reserve Board data bases and input to each model. The resulting quarterly forecasts were then matched against the economy's actual performance for each succeeding quarter. We found the percentage error between each model's forecast and the actual result. The forecast errors for each model were plotted against quarterly forecast periods. Figure 2 plots the envelope of forecast errors for the entire set of models.

Figure 2 shows us the percentage error between the forecast and actual performance for quarterly periods which had elapsed since the forecast was made.

It appears from Figure 2 that all models provide forecasts which are accurate to within $\pm$ .5% of the actual results for periods within 18 months of the date of forecast. After that, forecast accuracy rapidly deteriorated so that at 24 months, forecast errors are up to 5%; and by 36 months, errors are more than 20%. All models display these forecast limitations. What the data indicate is that the time constant of change for the U.S. economy may be of the order of 18 months. That is, one (or more) event(s) occur which affects some part of the economy, and 18 months later effects are seen on the gross economic performance.[17]

There is some reinforcement of that insight. In looking at change to the Consumer Price Index (CPI) during the 1970's, we found that as the price of energy changed remarkably, the structural balances[18] of CPI component elements did not reach stability for some time.

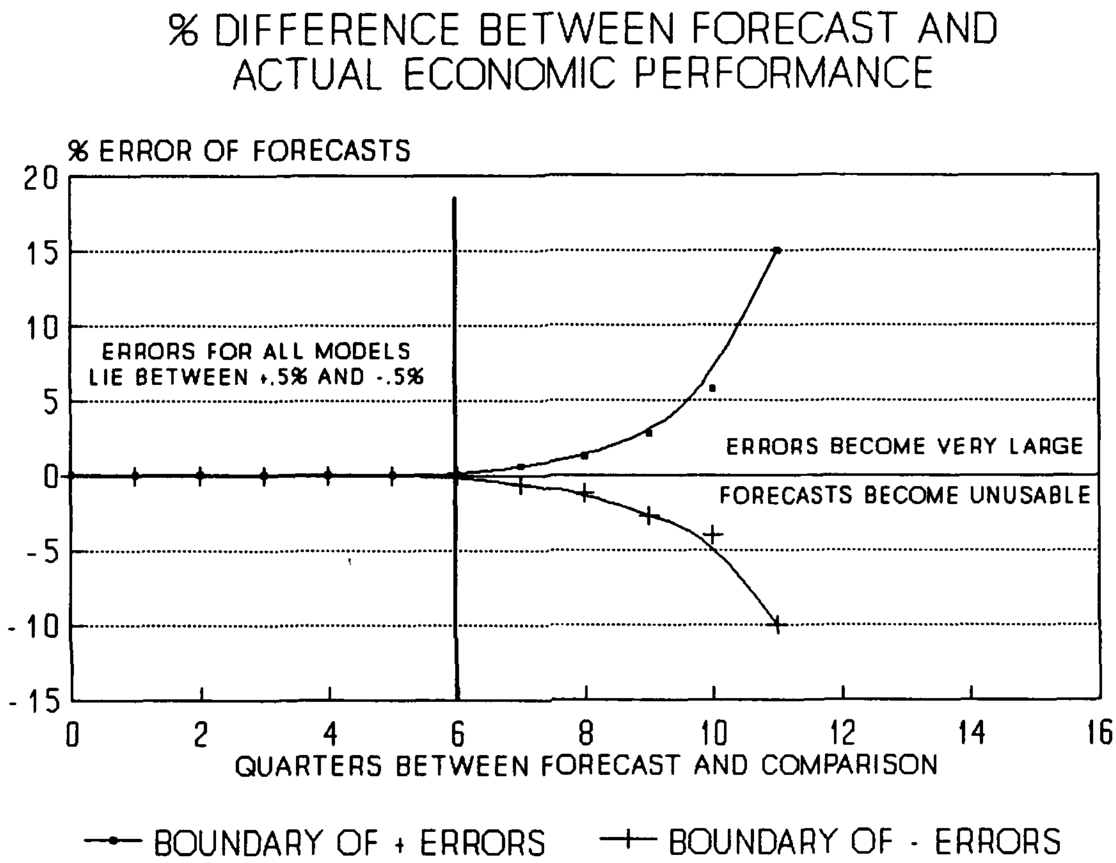


FIGURE 2

In fact, increases in oil prices migrated through the CPI in about 18 months.[19]

An additional observation might be derived by looking at economic events which occurred after enactment of the Tax Reform Act of 1986. The result of a major change in Limited Real Estate Partnership tax policy was lowered economic value of those partnerships.[20] Banks which held loan portfolios which were heavily weighted with limited partnership real estate ventures experienced devalued security against outstanding loans. As accumulation of value reductions continued for an extended period, some banking institutions found that not only did their portfolios no longer support the amount of loans outstanding against them, but also that the differences between debt and collateral value approached the institution's net capitalization. When that occurred, the institution was no longer considered viable. If additional capitalization was not quickly forthcoming, the institution was liable to seizure by Federal or State banking examiners. In regions where real estate

had been the "engine" driving "economic growth", the leveraged effect on other business created significant economic downturns. A chief example was the New England Region centered around Boston, Massachusetts, extending south to Hartford. Connecticut, and North to Portland, Maine. Another is the State of California which is currently experiencing a recession based on both real estate investment value depreciation and defense spending reductions. The banking problems became visible in 1988 as did the economic recession.

THE PERSPECTIVE OF EXPANDING BOUNDARIES OF INVESTIGATION

To develop a perspective of how changing boundaries of investigation and time constants of change affect the validity of research results, consider the following argument:

- **The Shock Tube Illustration:** The time required for creating major temperature stress in a shock tube wall was very much longer than the high temperature impulse generated by creation and passage of the shock front and its associated flow. But the time necessary to establish a stable supersonic flow regime around the model was much less than the duration of that flow generated behind the shock wave. Since both time constants were in "the proper relationship", reproducible data was collected over long periods of time. This is a case of "tightly focused" experimentation with a narrow boundary.

- **The Army Tactics and Doctrine Illustration:** The time required to make the appropriate numbers of measurements, analyze and interpret the experimental results of tactics and doctrine development was quite long. When using the same players, as the structure and order of the task sequences used changed, performance from trial to trial changed too: that is, results became increasingly less reproducible as the experimentation process proceeded. Later tests using other groups of players did not generally reproduce previous results. It seemed that the time constants of player learning were much shorter than the time required to complete the experimentation for this quite large problem boundary. The hypothesis was: when a boundary became large enough to encompass interrelated people and equipment, it also became "too wide" to permit gathering reproducible data within the time period required.

- **The Educational Conditions Illustration:** The estimated time required to collect sufficient data to address the question of how conditions of learning affect the actual learning achieved was of the order of 18 months. So many variables were incorporated within the boundaries required to generate an understanding of the question that even if sufficient population could be developed, the time required to make the measurements and the effects of making them[21] very likely would permit sufficient cultural change and learning outside the bounds of the experimental situation to mitigate against result stability and reproducibility. Because the time constants of human learning appeared to be shorter than the time required to understand them, we believed that in this wide boundary case, any results we achieved would likely be of short temporal validity.

- **The U. S. Economy Illustration:** The boundary of the U.S. economy is as large as the country itself. Furthermore, the effects we seek to understand are generated by accumulations of the individual actions of large numbers of people. Because the event of change is perceived differently by individuals, and because all individuals' responses must aggregate to make their effect felt, the time constants of stimulative change are much shorter than those associated with aggregated responses. Although that relationship introduces stability in the forecasting process, it limits very much the time period over which that stability can be expected to persist.

In other words, the question being asked is:

Do differences in

- complexities of structure inherent in broadly based systems considered as a single entity,

- human capacity to learn while working within broadly bounded systems, and
- the "time constants of change" for each "system component",

make achievement of "reproducible" observations of broadly bounded, complex systems, over time and space so difficult as to be unlikely?

THE IMPLICATIONS OF THIS PAPER

When we seek "scientific" research results which are reproducible across time and space, we must look very carefully at the data we obtain from investigations of broadly bounded, complex problems.

Research into complex systems behavior may last over long time periods, perhaps years. During that period, changes may have occurred to one or more fundamental elements within the complex system, or individuals within the system may have adjusted their behavior. The environments within which the research was conducted may even have become unstable or even have disappeared. Completed research results may quickly be overtaken by events if the research program has continued for longer time periods than the research environment or participants responses can be expected to remain stable.

It may be that some research results for broadly bounded, complex systems have only transient validity.[22] If that were the case, it would imply that achieving data reproducibility ("scientific" validity) would limit research programs to relatively short durations within rather narrow boundaries. It might also imply that knowledge obtained from such research activities should be used *before its validity is reduced!*

But it may also be easier to devise research designs for problems with narrower foci of study; studies which can be completed within short enough time periods to preclude much change in what we measure or in the environment which embeds the problem. But when we study complex interacting man-machine systems which must necessarily involve large experimental populations, there are so many possibilities for change that achieving unchanging research results may be beyond the capabilities of our current knowledge and methodology base.

If one thinks about decomposing broadly bounded problems to achieve narrow focus components, the problem becomes one of correctly structuring interactive knowledge from decomposed elements. Though that methodology might achieve time constants of change which help extend result validity for the decomposed units, the advantage might not extend to the imputed total interactive structure. The data we do obtain may not retain its validity over a long enough time to be applied usefully.

In fact, any narrowing of the boundaries and scope of research inquiry to achieve "scientific validity" may exclude many avenues of investigation crucial to a nation's cultural development.

In short, taken as a set, the hypotheses presented here might require us to

- recognize the need for research designs which take account of how the scope of the investigation affects the time periods during which results will be valid; and, perhaps even more importantly,
- reexamine our belief that once a research program has been accomplished, we can institutionalize actions based on those results.

The latter point is of great potential importance to those who make policy. If research results were to be of uncertain and transient validity, then their use as the basis for detailed institutionalization may encourage (or even insure) responses which might be most appropriate to solve problems of the past within the environment of that time. The solutions might be much less suitable to solve current problems within a quite different current environment.

END NOTES

1. The case can be made that Newtonian physics treated large aggregations of particles (or molecules) and the rules which were derived to explain behavior of large integrated bodies broke down when the body's constituent, smaller particles were considered. The need to deal with particulate "body" behaviors led first to development of *duality concepts for electromagnetic radiation in the visible spectrum*: (that is, light behaves as if it were both a wave and particles), thence to *quantum theory* for groups of particulate matter acting together within similar environment, and finally to *quantum electrodynamics* which deals with characteristics of individual particles acting individually within an environment.

2. Results of that experimentation determined defense force configurations for many years.

3. We might decide that testing a new tank's effectiveness required a platoon of new tanks to oppose a platoon of old ones in a set of one or more battle scenarios. We would repeat them using different soldiers. The number of times we repeated each experimental sequence and the numbers of different soldiers used were derived from statistics of stochastic processes. The usual result was a set of experimental matrices with numbers of replications stipulated for each matrix cell.

4. "Everyone knows" that rogue data is not useful for statistical analysis.

5. I came to recognize later that when dealing with systems within which humans are included, the process which governs system performance seems to obey a rule which can be stated as: Task performances I observe today integrate the total life experience up until today.

6. The two repeated sequences, Task 3 followed by Task 4 (in trials 1 and 2) and Task 5 followed by Task 2 (in trials 3 and 4) offer a chance to test the hypothesis that results when tasks are performed in particular sequences will be closer than will results when those same tasks are performed in a variable set of sequences.

7. That is, the Army's Experimentation process as practiced by CDEC in formulating tactics and doctrine.

8. At that time, Nicholas Katzenbach.

9. That is, the numbers of participants necessary to provide data of sufficient statistical robustness was very large indeed; and it would be very difficult to find relationships resulting from so complex a matrix array.

10. The Stockholms Enskilda Bank was then owned by the seven Swedish industrial families which included the Soderbergs, the Wallenbergs, and Axel Johnson. It has since been merged with the Sveriges Handlesbank to form one of the largest industrial and credit banks in Europe.

11. These included ASEA (now ASEA-Brown-Bovary), Electrolux AB (the world-wide vacuum cleaner company), AVESTA Industrie (specialty steel mills throughout Europe), Scandinavian Airlines System, and Axel Johnson Industries (Shipping and transportation, light manufacturing throughout Europe) and others.

12. Associate Professor, Simon Fraser University, Vancouver British Columbia, Canada.

13. That is, the owners rather than the State would set sale prices for items produced and sold.

14. The businesses and the entrepreneurs were taxed at the normal rates however and the State recovered funds from those taxes.

15. Performance envelopes for tanks, aircraft, and ships are commonplace and are the bases for complex training devices.

16. Psychologists have achieved considerable success in analyzing observed behavioral patterns of selected groups of individuals to determine "normal behavior" for those groups. There has been only limited success in predicting what individuals will do under hypothesized circumstances. There is even some difficulty in predicting how long a group behavior, once observed, will be sustained; especially under conditions of rapid change within the society.

17. See the report, "Accuracy of Economic Forecasts", General Research Corporation Report to the Director of Compensation, U.S. Navy, Office of the Chief of Naval Operations, 1979. Since economics depends heavily on how large number of individuals respond over time we came to believe that it took some time before individual "people" response changes accumulated into measurable effects in a macro-economic model.

18. The Consumer Price Index is composed of a number of sectors such as "energy", "housing", "food", "medical expenses", and so forth. When the economy is "stable", the relative values of each of these segments with respect to all other segments remains reasonably constant to within small percentage change boundaries. Usually, major change in one sector results in adjustment of other sectors over time.

19. See "Rate of Change of the Consumer Price Index in Response to Exogenous Economic Events"; General Research Corporation Report, 1980

20. In many cases, the value of the real estate was essentially the value of the tax shelter the partnership created.

21. Heisenberg's uncertainty principle, loosely interpreted, can be seen as stating that the making of measurements disturbs the situation being measured; thus there are limits to the things we can know about complex situations.

22. That is, they are truly valid only during the research process itself.

A METHODOLOGY FOR COST AND OPERATIONAL EFFECTIVENESS ANALYSIS (COEA)

Michael D. Bates
Mary T. Benze

Office of Aerospace Studies
HQ AFMC/OAS/XRC
Kirtland AFB NM 87117-6008

18 February 93

DISCLAIMER NOTICE

ABSTRACT

The purpose of this paper is to present a system of methods, principles, and rules that will aid in the satisfactory accomplishment of the Cost and Operational Effectiveness Analysis (COEA). This paper provides a brief introduction to the COEA process, describes when a COEA is required, how COEAs are used, how to prepare for the COEA, describes the analysis process while focusing on the basic elements of the COEA, discusses organizational responsibilities, the report format, and concludes with a summary of the COEA review process. The general framework for this paper is based on the Office of Assistant Secretary of Defense COEA Guide, *Cost and Operational Effectiveness Analysis (COEA)* and Air Force Materiel Command (AFMC) Pamphlet 173-1, *AFMC Cost & Operational Effectiveness Analysis (COEA) Guide*.

INTRODUCTION

For most acquisition programs, COEAs provide critical information essential to the decision making process. The COEA evaluates the costs and operational effectiveness of alternative courses of action to meet recognized defense needs. The COEA is a required DOD systems acquisition analysis that provides cost and operational effectiveness data for a particular concept under consideration. COEA data developed during the analysis of the concept or system enhancement are compared to similar data from alternative systems or system enhancements under consideration. This process assures that only the most cost and operationally effective systems are brought into the military inventory.

The COEA will typically draw on several sub-analyses. These include analyses of mission needs, the threat(s) and U.S. capabilities, the interrelationship of systems, the contribution of multi-role systems, measures of effectiveness, measures of performance, logistics, costs, and cost-effectiveness comparisons. Collectively, these sub-analyses provide the information necessary to answer the many questions generated by the acquisition management system process.

The DOD acquisition management system is comprised of five phases linked by

decision points or milestones. At each milestone, the decision to proceed is based on information developed during the previous phase. As the process proceeds from concept definition, through demonstration and validation, development, production and deployment, to operations and support (O&S), the milestone reviews aim to ensure that the program will satisfy user needs and remain within the approved program effectiveness and financial constraints. Figure 1 depicts the current acquisition milestones and phases.

DOD Instruction 5000.2, dated 23 February 91, mandates COEAs for ACAT I programs at Defense Acquisition Board (DAB) Milestones I and II reviews. COEAs may also be required for Milestones III and IV. The COEA provides vital information to decision makers and supporting documentation for these critical milestone decisions.

THE COEA REQUIREMENT

All acquisition programs are based on mission needs identified by the Unified and Specified Commands, Military Departments, OSD, developers and other relevant organizations. Needs can be based on deficiencies, opportunities, or obsolescence issues. The needs are identified by assessing current and projected threats and taking into account the changing national defense policy. The COEA, an analysis based on mission needs, considers all of these factors.

COEAs are required for DOD Acquisition Category (ACAT) I programs and may be required for ACAT II, III, and IV programs. They provide comparative analyses of the costs and operational effectiveness of alternative solutions intended to satisfy an established mission need. The information and supporting documentation that results from the COEA process is critical for selecting the best possible system to

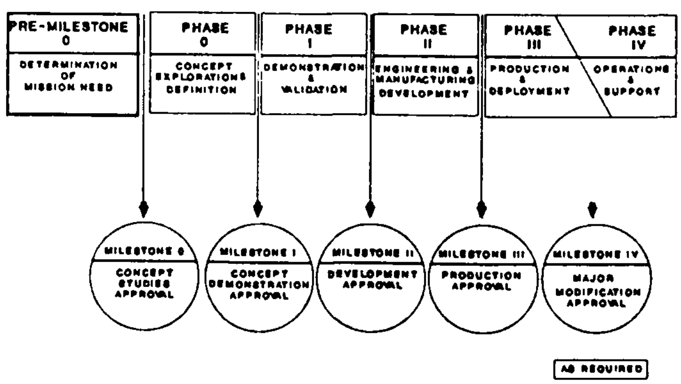


Figure 1. Acquisition Milestones and Phases

satisfy user requirements. Each COEA will deal with a different system, and depending on the program size and the phase of the development process, may differ significantly in scope.

Responsibility for the preparation of COEAs usually rests with the Military Department or Defense Agency responsible for the mission area encompassing the identified mission need. A lead service is designated for joint programs; the Joint Staff may be designated as lead in certain cases. For Air Force programs, the Office of Assistant Secretary of the Air Force for Acquisition (ASAF/A) gave the responsibility for preparing Phase 0 and Phase I COEAs to the operational commands, with support and assistance of the implementing command (Action Memo, 10 Nov 89, ASAF/A).

HOW COEAs ARE USED

COEAs are submitted by the military services at designated milestones in the acquisition cycle. They provide an evaluation of the costs and benefits--the operational effectiveness or military utility--of alternative courses of action to meet recognized defense needs. One of the alternatives typically represents the current program or status quo. Another is usually an improved version of the current program. Other alternatives are assessed against these cases in terms of their changes in cost and effectiveness. COEAs provide information on the sensitivity of alternatives to potential changes in key assumptions, variables, and constraints. They aid decision making, facilitate communications among OSD, service principals and staffs, and document acquisition decisions by providing a record of the alternatives considered. COEAs should be homogenous with other acquisition support documentation such as the Mission Need Statement (MNS) and the Operational Requirements Document (ORD).

COEAs are one of many required supporting documents in the complex acquisition process. They are required prior to major decision points by the Defense Acquisition Board (DAB) at Milestones I, II, and IV. The DAB may also require COEAs at Milestone III as program changes warrant. In addition to providing insight into the relative advantages/disadvantages of the many alternatives being compared, the COEA facilitates discussions between the major participants (OSD, AF, and the using and implementing commands) at early stages to settle concerns and/or disagreements. The COEA documents the analytical process and provides data for milestone inputs and decisions.

COEA PREPARATION

This section describes the activities that occur in the COEA process from Pre-Milestone 0 through Phase III. It also provides discussion of the study plan developed at Phase 0. The greatest emphasis in this section is on Phase 0, because the activities that occur in this phase are

replicated to a greater or lesser degree in the subsequent phases.

PRE-MILESTONE 0 - The needs identified in the Mission Area Assessment (MAA) and the supporting Mission Need Analysis (MNA) may come from a variety of sources within or without the operating command. Deficiencies that can be satisfied by changes in doctrine, tactics, training, or organization are sent to the military department for consideration and action. Deficiencies that could potentially result in the establishment of a new or enhanced program are documented in a Mission Need Statement (MNS), and the process proceeds to a Milestone 0 decision. The individuals and organizations responsible for preparing the COEA should be aware of the issues raised during this phase of the acquisition process.

PHASE 0 - Phase 0 COEA activities are illustrated in Figure 2. The study plan that is developed and the analytical process that occurs during this phase culminate in the report used for the Milestone I decision.

PHASE I - During Phase I, the demonstration and validation phase, the COEA plan must be updated to identify the Phase I analysis. The COEA prepared during this phase can be much more detailed than the previous phase. There are fewer alternatives, which can be described with more confidence in terms of cost and performance. The demonstration and validation tests performed on the alternatives will provide useful data for the analysis.

The COEA analysis should once more visit the go/no go question (see Figure 2), making use of the better alternative definitions and any new information. Assuming that the acquisition process is to proceed, the goal of this COEA is to identify the preferred alternative. Sensitivity analyses should quantify the impact on cost

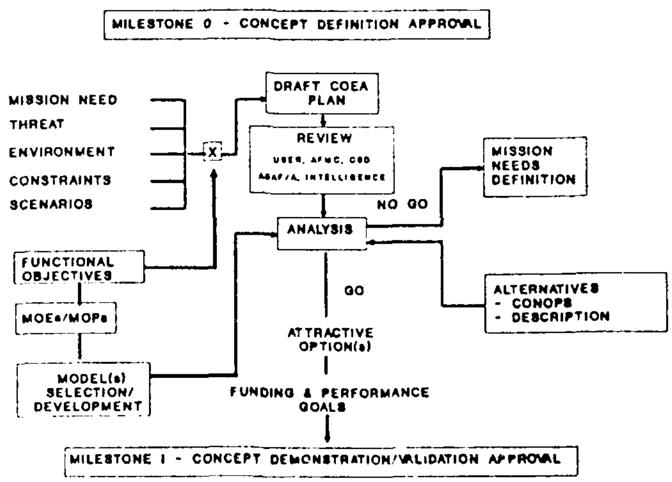


Figure 2. Phase 0 COEA Activities

effectiveness of uncertainties in cost, performance, supportability, and schedule. The analysis should identify cost ceilings and performance floors.

Figure 3 highlights the differences between Phases 0 and I in the application of COEA elements. The system alternatives in Phase I typically represent a narrower range, with more information and definition. Therefore, the analysis can be more detailed and specific. The additional information should permit much better cost and performance estimates of the alternatives. Point estimates should be made and bounded by a range of uncertainty. To lessen uncertainty and to accomplish relative life cycle cost comparisons, the data should incorporate any available engineering or "bottom-up" costing method. However, since life cycle costing is seldom a pure engineering estimate, a combination of engineering, analogy, and parametric cost estimates is usually necessary.

ELEMENT	PHASE 0 COEA	PHASE I COEA
Mission Need	Confirm	Reconfirm
Threat	Confirm	Reconfirm
Environment	Identify	Validate
Constraints & assumptions	Identify	Validate
Scenarios	Develop	Validate
Concept of Operations	Develop	Validate
Description of alternatives	Describe	Refine/focus
Functional objectives	Identify	Validate
MOEs/MOPs	Identify	Validate
Models	Identify/develop	Validate
Life cycle cost	Prepare	Refine
Analysis	Perform	Perform
Preparation of Report	Prepare	Prepare

Figure 3. Comparison of the Application of the Key Elements in Phase 0 and I COEAs

PHASES II AND III - Figure 4 illustrates the activities in Phases II and III. In preparation for Milestone III, the acquisition decision authority may require that the COEA be updated to account for any factors which may have changed during the preceding phase. If a major modification is anticipated, the decision authority may require that a new COEA be performed in preparation for Milestone IV. The requirements for this COEA will be delineated in the planning phase.

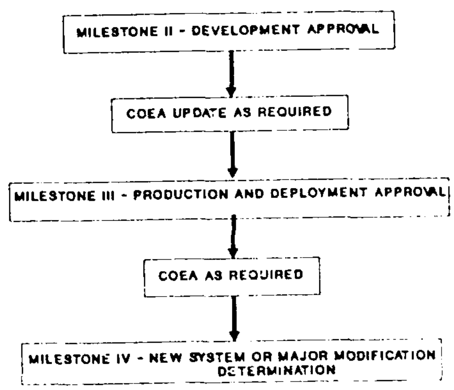


Figure 4. Phases II and III COEA Activities

STUDY PLAN - The first task of COEA preparation is the development of a study plan. While this plan focuses on the Phase 0 COEA, it forms the basis for the Phase I and subsequent COEAs as well. The plan should include discussion of the mission need, threat, environment, constraints and assumptions, scenarios, concept of operations, description of alternatives, methodology, functional objectives, measures of effectiveness, measures of performance, logistics, acquisition cost (R&D and investment), operations and

support cost, disposal cost, military construction cost, and models and data. Figure 5 presents a suggested study plan.

TITLE
1. INTRODUCTION
   a. Background
   b. Purpose
   c. Scope
2. ORGANIZATIONAL RESPONSIBILITY
   a. Study Team/Concept Action Group (CAG)
   b. Study Advisory Group (SAG)
3. ACQUISITION ISSUES
   a. Mission Need
   b. Threat
   c. Environment
   d. Constraints and Assumptions
   e. Scenarios
4. ALTERNATIVES
   a. Methodology
   b. Effectiveness Analysis
      (1) Functional Objectives
      (2) Measures of Effectiveness
      (3) Measures of Performance
      (4) Models and Data
   c. Life Cycle Cost Analysis
      (1) Acquisition Cost
      (2) O&S Cost
      (3) Disposal Cost
      (4) MILCON Cost
      (5) Models and Data
   d. Cost/Effectiveness Analysis
   e. Tradeoff Analysis
   f. Other Supporting Analyses
5. REPORT FORMAT
7. SCHEDULE
8. REVIEW PROCESS
9. ACRONYMS
10. REFERENCES

* The study leader will identify an OPR, approach, and schedule for these elements

Figure 5. Suggested COEA *Study* Plan Format

The study plan should outline an approach (methodology) for performing the analysis, identify tasks to be performed, and present a schedule for completing the effort. The detail required in the study plan may vary depending on the size of the anticipated development program. The plan should be prepared by the operating command leading the effort, with support from the implementing command (usually AFMC) and the support agencies (AFOTEC, AFSAA, AFCAA, AFMC as appropriate). The plan should be coordinated with the implementing command's DCS for Requirements, the appropriate support agencies and the SAF/AQ and, for ACAT ID programs, be reviewed with the OASD/PA&E. This will help ensure that all logical, viable alternatives get a fair assessment and that mission area parochialism is kept at a minimum. The plan should be maintained and updated throughout the COEA process.

ANALYSIS PROCESS

The purpose of the analysis is to identify the strengths and weaknesses of the alternatives, determine costs, and to ultimately identify the preferred solution. The analysis process, as outlined in the study plan, may be performed by in-house study groups, by or with the support of the AFMC product and logistics centers, or by contractor teams if funding is available. Several of the COEA elements listed in the study plan can be categorized as administrative: the study team, the study advisory group, the report format, the schedule, and the review process. These *who* and *when* elements will be discussed in the sections addressing organizational responsibilities, report format, schedule, and the review process. The bulk of the elements listed in the study plan are analytical elements in that they help determine *what* will occur in the COEA process. These elements will be discussed in turn under the categories of acquisition issues, alternatives, and analysis. Additional information on the COEA elements is contained in Attachment 2 of AFMC Pamphlet 173-1. The following paragraphs address critical elements of the analysis process.

ACQUISITION ISSUES

MISSION NEED - It normally will not be necessary to apply extensive effort to develop or rejustify the mission need. It may be sufficient to review the original justification. Some questions to consider:

- Is the need derived from and compatible with higher echelon operations?
- Was it derived from a deficiency that is likely to occur over a broad spectrum of conditions or will the need arise only in unique or unlikely circumstances?
- Was it based on comparisons of a valid threat and friendly capabilities projected within the same time frame?
- Have any changes occurred either in the threat, world situation, strategy, or technology capabilities that could have significant impact on the need?

THREAT - Describe the threat in sufficient detail so that the effect of the alternatives can be assessed. Always address the following:

- Get the intelligence community (operating command, DIA, USAF/IN, etc.) involved early to confirm the threat.
- Include a range of threats to account for uncertainties in the estimates.
- Include any limitations that will impact threat effectiveness, such as logistics, limited operational capabilities, strategy or tactics, and technology.
- Aim for a realistic threat description; avoid overestimating the threat capabilities.

ENVIRONMENT - The nature of the need will dictate the susceptibility of the analysis to environmental influences. For example, a surveillance system may be impacted greatly by the weather, while a communications system may experience relatively little impact. When considering environmental factors, one should always:

- Identify those factors that will significantly impact the developmental system.
- Identify the range of the factors that could be expected.

CONSTRAINTS AND ASSUMPTIONS - Identify the constraints and assumptions that will significantly impact the COEA. They form one basis for the sensitivity analyses that must be performed. Key constraints and assumptions to be considered are:

- Limitations on personnel available for either operation of the system or its support.
- Limitations on funds available for development, investment, or O&S.
- Any obvious technological limitations.
- Limitations imposed by schedule requirements or logistic constraints.
- Limitations imposed by environmental, treaty, legal, or political constraints.

SCENARIOS - Thoroughly define and develop the scenarios in which the alternatives will operate. The scenarios draw on the need,

the threat estimates, the operational concepts, and the environmental constraints. One of the scenarios should be identified as the baseline. Consider the following:

- The scenarios should describe both friendly and enemy forces in terms of their numbers, capabilities, deployments, and employment concepts.
- Include environmental factors that impact operations.
- Include logistic factors that impact operations.
- The baseline scenario should comply with the *Illustrative Planning Scenario*.
- Other scenarios can be developed to investigate the robustness of the alternatives to changes in constraints and assumptions, threat, etc.

ALTERNATIVES - Alternatives must address the concept of operations (CONOPS) as well as describe the alternatives.

CONCEPT OF OPERATIONS - Develop a concept of operations for each alternative. In doing this one should:

- Describe how the system will be deployed during operations.
- Identify staffing levels to operate and support the system.
- Describe how the system will be operated and maintained and its interactions with other operating systems.
- Describe how the system fits into the existing command and control system. Identify any unique requirements.
- Describe the basing mode and any unique requirements for basing, logistics, support, etc.
- Identify organic and contractor support requirements.

DESCRIPTION OF ALTERNATIVES - The set of alternatives should contain the present capability within the current organizational structure as the base case or reference alternative and incorporate the following as appropriate:

- Include the current system as base case.
- Use the current system with product improvement(s).
- Include systems currently under development.
- Add conceptual systems, if available in the required time frame.
- Include systems of other services or foreign governments.
- Use commercial systems, if applicable.

Include a manageable range of alternatives. Avoid including alternatives that are obviously unsuitable. If there is a question as to the suitability of an alternative, include it. On the other hand, if rough order of magnitude (ROM) estimates of cost or performance indicate an alternative is clearly unsuitable, the estimates need not be refined. The subsequent analysis should resolve the issue. Allow for new or modified alternatives to be added as the analysis proceeds and new options are identified or old options refined.

Include as much detail as possible in the alternative

descriptions. As a minimum, provide the following:

- System characteristics --size, weight, shape, etc.
- System performance -- rate of fire, speed, range, lethal area, payload, detection range, availability, etc., as appropriate.
- Special support requirements -- computer resources, maintenance, fuel, supply, etc.
- An estimate of the life cycle cost for each of the alternatives in terms of R&D, investment, O&S, and disposal.

During the Phase 0 COEA effort, there will be considerable uncertainty in both the performance and cost estimates. In many cases, they are only predictable in terms of error or confidence bands. The uncertainties and the source of all information must be documented.

ANALYSIS - Analysis includes such activities as methodology development, effectiveness analysis, life cycle cost analysis, cost/effectiveness analysis, tradeoff analysis, and other supporting analyses such as logistics.

METHODOLOGY - A systematic methodology, the first step in the analysis process, must be developed to determine how the alternatives will be evaluated. The methodology should be clearly defined for the effectiveness analysis, cost analysis, and any required supporting analysis. In developing the methodology:

- Confirm that the methodology is logically sound.
- Make sure all critical elements are included.
- Coordinate the methodology with OASD(PA&E) for ACAT ID programs or an independent source (usually AFMC/OAS) for other acquisition categories.

EFFECTIVENESS ANALYSIS - The effectiveness analysis quantitatively measures if the performance level achieved by a given alternative satisfies a set of specific, pre-established requirements. Key elements of the effectiveness analysis are functional objectives, measures of effectiveness (MOEs), measures of performance (MOPs), and models and data. When performing the effectiveness analysis:

- Identify the probability that the proposed system will operate when required.
- Include issues of survivability and vulnerability to countermeasures.
- Address issues of availability, maintainability, and safety.

FUNCTIONAL OBJECTIVES - Functional objectives are goals that the system will be expected to meet. They act as standards for comparing alternatives. Functional objectives should:

- Translate the requirements (tasks to be accomplished) of the MNS and ORD.
- Be measurable in terms of quantitative measures of effectiveness (MOEs).
- Be tailored to the type of system under consideration

(e.g., the new weapon system will be capable of attacking and killing xyz targets).

- Relate to the mission need (e.g., the functional objective of destroying bridges is probably not pertinent if the mission need is to locate and destroy aircraft shelters).
- Relate to system design requirements such as reliability, availability, maintainability (RAM).

MEASURES OF EFFECTIVENESS - Be careful not to confuse measures of effectiveness (MOEs) and functional objectives. A functional objective is a goal; an MOE is the degree to which the alternatives satisfy the goal. An MOE for the above example is the probability of achieving a kill on the xyz target. When developing MOEs consider the following:

- MOEs should provide a measure of how well the alternative is meeting the functional objectives.
- Try to identify more than one MOE. Increasing the number of MOEs will tend to increase confidence in the robustness of the results.
- The set of MOEs developed should encompass all of the functional objectives.

MEASURES OF PERFORMANCE - Measures of performance (MOPs) are defined as quantitative measures of the lowest level of physical performance (range, velocity, throughtput, etc.) or physical characteristics (height, weight, volume, frequency, etc.) of an alternative. In short, MOPs are system specifications. MOPs such as range and speed or height and volume should relate to MOEs such that the effects of a change in the MOP can be related to a change in the MOE. MOPs should indicate exactly what system performance characteristic is to be measured. When developing MOPs:

- Use such specification items as range, speed, payload, and radar cross section as MOPs.
- Identify characteristics such as height, weight, and volume that result from a system design solution.
- MOPs should provide information on whether the system has met required specifications.

MODELS AND DATA - Accredited models and data are essential to the effectiveness analysis process. The choice of models will be driven by the need, operational concept, threat, functional objectives, MOEs, and MOPs. Each model should be sufficiently detailed so that it can accommodate the chosen scenario(s), as well as assess the sensitivity of the alternatives to changes in assumptions, threat, etc. When choosing the model(s), consider the following:

- If possible, select models and data that have been screened through a formal Verification, Validation, and Accreditation process (VV&A).
- Choose the simplest model(s) that can perform the necessary calculations and the appropriate sensitivity investigations.

- Use existing widely accepted models where possible. Development of large scale models can be expensive and time consuming.
- Apply the model to the baseline alternative first. In general, the existing system will be better understood than any conceptual alternative. Explain any differences between model results and known baseline performance.
- Make sure the model is well understood and that any apparent anomalies can be explained.
- Where possible, apply the same model to all alternatives.

An important point to remember is that data should undergo many of the same checks performed on models.

LIFE CYCLE COST ANALYSIS - Life cycle cost analysis provides a systematic procedure for estimating the aggregate cost of alternative systems, and it allows a comparison between alternatives based on economy. System life cycle cost consists of acquisition (R&D and investment), operating and support, disposal, and military construction (MILCON) costs. When performing a life cycle cost analysis:

- Consider acquisition costs, operations and support costs, and disposal costs for each alternative.
- Determine if independent cost estimates can be used for comparing alternatives.

ACQUISITION COST - This term is used within DOD to denote the aggregation of costs to develop, produce, and deploy a weapon system in its operational environment. It includes R&D and investment costs. Acquisition cost commences with Phase 0 and is usually completed when the last production unit is delivered to the using command. When developing the acquisition cost:

- Consider R&D and investment cost for each alternative.
- Take all computer resources, special support equipment, and facilities into account.

OPERATION AND SUPPORT (O&S) COST - O&S costs are those program costs necessary to operate, maintain, and support system capability. These costs include personnel, operations and maintenance, and recurring procurement appropriation costs such as replenishment spares. For O&S cost development:

- Make sure the CONOPS has been reviewed.
- If available, review related integrated logistics support plans for essential information.

DISPOSAL COST - This is the cost associated with getting rid of excess or surplus property or material from the Services' inventories under proper authority. It may also reflect the costs of hazardous waste disposition and environmental cleanup. When determining disposal cost:

- Account for the total system. This includes support items necessary for oper-

ations, maintenance, security, storage, etc.

MILCON COST - This is the cost of supplies, equipment, and material required to provide military facilities necessary to accommodate each of the alternatives. When developing MILCON costs:

- Make sure MILCON requirements have been identified for all alternatives.

MODELS AND DATA - As with effectiveness models and data, cost models and data are critical to the performance of the COEA function. When selecting these items:

- Make sure the cost models and data selected to support the COEA are accredited by the responsible costing agency.

COST/EFFECTIVENESS ANALYSIS - A cost/effectiveness analysis is an analytical method examining the cost and performance of alternative means of accomplishing desired military missions. It requires the definition of objectives, as well as identification of alternative ways of achieving each objective. When performing the cost/effectiveness analysis:

- Identify alternatives meeting system objectives that yield the greatest benefit for a given cost or the required level of benefit at the lowest cost.
- Maintain a balance between cost and effectiveness.
- Compare equal cost or equal effectiveness alternatives.
- Stay away from schemes with weighted measures.
- Avoid ratios: they tend to ignore sufficiency and mask important differences.

TRADEOFF ANALYSIS - The purpose of the tradeoff analysis is to identify the strengths and weaknesses of the alternatives and to identify the preferred solution. The MOPs and the cost for each alternative are used to investigate the utility of changes in each measure. This process is one of comparing alternatives on the basis of equal cost and/or equal effectiveness, assessing the effects of uncertainty and sensitivity, and establishing performance and cost thresholds. The final task is to prioritize the alternatives. There is no cookbook approach. Key items should be assessed, such as cost, effectiveness, logistics, risk, countermeasures, and military utility. When executing the tradeoff analysis:

- Compare alternatives on the basis of equal cost and/or equal effectiveness.
- Be concerned with real issues, such as national security, force structure, the world political scene, U.S. industry, the environment, and energy needs.

OTHER SUPPORTING ANALYSES - This category of analysis includes all other applicable analyses that do not fall under the categories of cost or effectiveness analysis. Support analyses should identify any analyses needed to support the COEA, such as MNAs, MAAs, environmental analyses, economic analyses,

logistics analyses, and manpower studies.

ORGANIZATIONAL RESPONSIBILITIES

As stated earlier, it is the responsibility of the operating command to prepare the COEA. The operating command is therefore obligated to develop its own organization and procedures for accomplishing the COEA. The following material is suggested as a model for the operational organization. It should be tailored to the specific operating command's organization and approach to weapon systems acquisition.

ORGANIZATION - At least two groups should be established when developing COEAs for a major program: a study team and a study advisory group (SAG). The suggested composition and roles of these two groups are discussed in the following sections.

STUDY TEAM - The study team should include members from the operating command's DCS for Operations, Requirements, Plans, Intelligence, Financial Management/Comptroller, and Logistics, as well as representatives from other functional areas as needed. For example, a weather staff officer is important for COEAs with environmental sensitivities. The study team should also include members from the implementing command (usually AFMC) and support agencies (AFOTEC, AFSAA, AFCAA, AFMC, etc.). On programs involving AFMC, members from the appropriate AFMC/XR and FM centers should be included. On joint programs, members from other services or the Unified Commands should be included. Study team members should be responsible for material to be supplied by their respective DCS. The study team leader should exercise overall responsibility for coordination of the efforts. He or she should report directly to the commander (CC) of the operating command.

Figure 6 illustrates the relationship between the study team and the supporting organ-

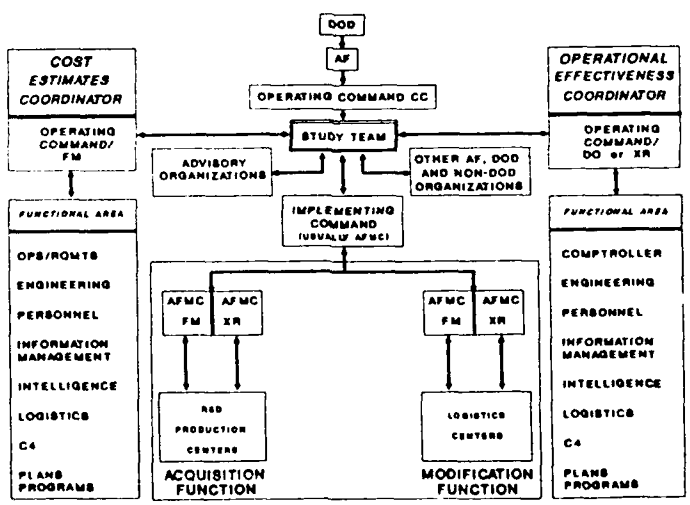


Figure 6. Relationship Between Study Team and Supporting Organizations

izations. The study team will concentrate on two general areas: cost estimates and operational effectiveness.

The operating command study team member from FM should be responsible for coordinating the cost estimates. Operating command support should be drawn from the cost communities of the functional areas (engineering, personnel, logistics, etc.). Support should also be drawn from the FM organizations within the implementing command.

The operational effectiveness area should be coordinated by a team member from the operating command staff, generally from the DCS for Operations or Requirements. As with the cost estimates, support should be drawn from the operational command functional areas, as required, and from the appropriate functional areas of the implementing command. A suggested division of responsibilities between the study team and the supporting organizations is given in Figure 7.

STUDY ADVISORY GROUP - In order to ensure that the operating and implementing commands and the decision makers continue in concert throughout the development, a study advisory group (SAG) should be formed. The SAG should consist of senior representatives (O-6 or above) from the principal organizations on the operating command staff and representatives from the implementing command, SAF/AQ, SAF/FM, and USAF/XO. For ACAT I programs, the SAG should include a representative from the Office of the Assistant Secretary of Defense for Program Analysis and Evaluation (OASD/PA&E).

The SAG should review the COEA effort at the following specific points in the COEA development process:

- Completion of the COEA plan prior to the Phase 0 analysis.
- Completion of the Phase 0 COEA analysis prior to submitting results to the Milestone I review.

ACTION	LEAD	SUPPORT
Study team leader	TBD by OC/CC	
Study plan	Team leader	Study team
Costing Information	OC/FM	IC/FM
Concept of Operations	OC/DO	OC/XP
Threat analysis	OC/IN	DIA, USAF/IN, AFIC
Environmental factors	OC/DO & WE	IC/WE
Constraints and assumptions	OC/XP or XR	OC/DO & IC/XR
Functional objectives	OC/DO or XP	OC/DO/XP/XR
Logistics	OC/LG	IC/LG
MOEs/MOPs	OC/DO,XP, or XR	OC/DO/XP/XR
Alternatives	Team leader	OC/XP or XR, IC/XR
Models	OC/Ops Analysis	OC/DO,XR&FM;IC/XR&FM
Analysis	OC/Ops Analysis	OC/DO,XR,FM;IC/XR,FM AFSAA; AFCAA
Report	Team leader	Study team

OC - operating command; IC - implementing command; TBD - to be determined

Figure 7. Suggested Division of Responsibility Between Study Team and Supporting Organizations

■ Completion of the updated COEA plan prior to the Phase I analysis.

■ Completion of the Phase I COEA analysis prior to submitting results to the Milestone II review.

For programs requiring a significant, long-term analytical effort, the SAG should conduct a review at about the midpoint of the analysis. A review of the alternatives selected for inclusion in the analysis also may be included for major efforts.

REPORT FORMAT

The COEA report should be as brief as possible (100 pages maximum). It should summarize the major elements of the COEA and present the results of the analysis in terms of relative affordability and utility of alternatives. A suggested report format is presented in Figure 8.

EXECUTIVE SUMMARY
RESPONSIBLE ORGANIZATIONS
1. PURPOSE AND BACKGROUND
2. ACQUISITION ISSUES
    a. Mission Need
    b. Threat
    c. Environment
    d. Constraints and Assumptions
    e. ScenariosN
3. ALTERNATIVES
    a. Concept of Operationsround
    b. Description of Alternatives
4. MODELS
    a. Effectiveness Models and Data
    b. Cost Models and Data
    c. Cost/Effectiveness Models
5. ANALYSIS
    a. Methodology
    b. Effectiveness Analysis
    c. Life Cycle Cost Analysis
    d. Cost/Effectiveness Analysis
    e. Tradeoff Analysis
    f. Decision Criterial Factors
6. CONCLUSIONS
    a. Resultational Objectives
    b. *Recommendations*
ATTACHMENT A: EFFECTIVENESS SUPPORTING ANALYSIS
ATTACHMENT B: COST SUPPORTING ANALYSIS
ATTACHMENT C: OTHER SUPPORTING ANALYSES
ACRONYMS
REFERENCES

Figure 8. Suggested COEA Report Format

REVIEW PROCESS

Experienced, senior-level people in the coordination chain should review the COEA at specified stages in its development. Their job is to ensure focused, sustained progress in developing a useful analysis to support program decisions by the Acquisition Executive and/or the Defense Acquisition Board (DAB). The coordination process offers a unique opportunity to improve the quality and develop wide support for the COEA. Early coordination is crucial to avoid disconnects and revision late in the COEA development process. While there is no formal checklist to assure a successful COEA, COEAs are evaluated on many of the *following points:*

■ What is the problem being addressed? Is it the real problem or only a symptom of a more basic concern?

■ Is the scenario consistent with the *Defense Planning Guidance*? Is the threat consistent with the DIA estimate?

■ Are the assumptions and constraints explicitly identified? Are they really constraints? Are they unduly restrictive? Are they defensible?

■ Is the CONOPS reasonable and complete?

■ Have any feasible, significant alternatives been omitted?

■ Were multiple MOEs used? Do they relate to functional objectives? Are the real measures of effectiveness or only measures of performance?

- Have all relevant costs been identified? Have significant cost drivers been identified? Have costs been reviewed by an independent second source?
- Are the models used in the evaluation adequately explained? Have they been through a VV&A process? Are the results obtained for the baseline system consistent with existing data from previous tests and studies?
- Has the database for the analysis been validated through engineering analysis or test information?
- Does the COEA address the cost and effectiveness of all the proposed alternatives?
- Are the criteria for selecting or ranking preferred alternatives identified explicitly? Are they meaningful and intuitively acceptable?
- Does the COEA identify the preferred alternative(s)? Are the reasons explicitly stated? Does the preferred alternative(s) offer distinct advantages over those alternatives not selected?
- Are the results of the analysis intuitively satisfying? Are they convincingly substantiated?
- Were sensitivity analyses conducted to show how changes in assumptions about performance, threat, environment, alternative costs, etc. affect utility, cost effectiveness, or schedule?
- Were other supporting analyses such as logistics, environmental impact, energy, economic and/or manpower studies performed?
- Has the risk associated with the development of each alternative been adequately addressed?
- Was the report format followed? If an item was not included, is there justification for its omission?

SUMMARY

The elements of a COEA range across several areas, such as threat, mission needs and U.S. capabilities, interrelationship of systems, multi-role systems, measures of effectiveness, measures of performance, supportability, costs, and cost-effectiveness comparisons. A successful COEA depends upon understanding and applying the elements effectively in the DOD system acquisition process.

Today's military system development programs generally exist in a complex environment, utilizing advanced science and engineering technologies. Funding shortages, competition within DOD for program dollars, the overall reduction of resources, and the opportunity for technical mistakes places a greater emphasis on the COEA process. As a result, it is strongly recommended that the elements of the COEA be identified and understood and that a study plan be initiated as early as possible in the acquisition process. The ideal time to start the plan is with the establishment of the requirements definition. The analysis that accompanies the development of the requirements may very well be the first evaluation of operational effectiveness. Understanding the requirements is the key to successful system development via the COEA process.

NOTE

A more detailed discussion of the COEA process is contained in AFMC Pamphlet 173-1, *AFMC Cost & Operational Effectiveness Analysis (COEA) Guide*, dated December 1992. Included in this document are attachments on DOD Acquisition Categories, Key Elements of a COEA, Sources of Costing Support, and Sources of Performance Simulation Support. The key elements of the COEA follow the form of the DOD publication, *Draft Cost and Operational Effectiveness Analysis (COEA) Guidelines*, Office of the Assistant Secretary of Defense (Program Analysis and Evaluation), February 1990.

BIBLIOGRAPHY

Defense Systems Management College. May 1990. *Teaching Notes*. Ft Belvoir VA.

Department of the Army. 4 April 1978. *Letter of Instructions (LOI) for Cost and Operational Effectiveness Analysis (COEA)*. Pentagon, Washington, DC: Department of the Army/ODCSOPS; DAMO-RQR Memorandum.

Department of Defense. February 1990. *Draft Cost and Operational Effectiveness Analysis (COEA) Guidelines*. Washington, DC: Office of the Assistant Secretary of Defense (Program Analysis and Evaluation).

Department of Defense. 23 February 1991. *Defense Acquisition*. Washington, DC: Department of Defense; DODD 5000.1.

Department of Defense. 23 February 1991. *Defense Acquisition Management Policies and Procedures*. Washington, DC: Department of Defense; DODI 5000.2.

Department of Defense. February 1991. *Defense Acquisition Management Documentation and Reports*. Washington, DC: Department of Defense; DOD Manual 5000.2-M.

Department of Defense. (Undated). *The COEA In Support of the DOD Decision Process* [Paper by Alfonso Diaz and Emily Goldman]. Pentagon, Washington, DC: OASD/PA&E.

Strategic Air Command. 26 April 1990. *Cost and Operational Effectiveness Analysis (COEA) Implementation Plan for Analysis*. Offutt AFB, NE: HQ SAC/XP.

Strategic Air Command. 27 April 1990. *Cost and Operational Effectiveness Analysis (C-O-E-A) Implementation* (Briefing Package). Offutt AFB, NE: HQ SAC/XPSM.

Strategic Air Command. 11 May 1990. *Cost and Operational Effectiveness Analysis* (Briefing by MG Fredrick A. Fiedler). Offutt AFB, NE: HQ SAC/DCS Requirements.

Strategic Air Command. 15 June 1990. *Operations Systems Analysis, Cost and Operational Effectiveness Analysis*. Offutt AFB, NE: HQ SAC XR/XP; Operating Instruction 57-2.

TRADOC Analysis Command. (Undated). *Cost and Operational Effectiveness Analysis* (Briefing Package). Ft Leavenworth, KS: HQ TRAC.

Training and Doctrine Command. 19 July 1985. TRADOC Pamphlet 11-08. Ft Lee, VA: TRADOC.

US Air Force. 29 May 1990. *Pre-milestone (MS) I Activities Study* (Briefing by Col Dick Jefferies). Pentagon, Washington, DC: USAF/XOXWR.

US Air Force Regulation (AFR) 57-1 (Draft). 22 October 1990. *Air Force Needs, Concepts, and Requirements*. Pentagon, Washington, DC: USA./XOXWR.

US Air Force Systems Command. December 1992. *AFMC Cost & Operational Effectiveness Analysis (COEA) Guide*. Wright-Patterson AFB, OH: HQ AFMC/XR; AFMC Guide 173-1.

US Army Materiel Command. 31 May 1988. *Concept Formulation Process (CFP) Memorandum of Instruction (MOI)*. Alexandria, VA: HQ US Army Materiel Command; ATCD-ET Memorandum.

EFFECTS OF THE POLITICAL ENVIRONMENT ON IMPLEMENTATION OF TECHNOLOGICALLY ADVANCED WEAPON SYSTEMS:
The North American B-70 Bomber

Capt Gary Beatovich, USAF

ABSTRACT

This paper discusses bringing technologically advanced weapon systems into current military inventory, and why difficulty is often encountered in the process. This paper uses one example, the North American B-70 bomber program, to illustrate inconsistent political support and the reasons behind it. Like many other advanced programs, the B-70 was cancelled due to a lack of political support. The research associated with this paper compiled a complete and chronological history of the political actions surrounding the North American B-70 bomber program, from its beginnings to the rollout of the first prototype, in May 1964. This paper outlines what elements define the political environment a system must survive, and uses the B-70 bomber program as an example.

EFFECTS OF THE POLITICAL ENVIRONMENT ON IMPLEMENTATION OF TECHNOLOGICALLY ADVANCED WEAPON SYSTEMS: The North American B-70 Bomber

Capt Gary Beatovich, USAF

INTRODUCTION

Implementing large-scale technology advancements into current military inventory is often controversial and costly. The B-2 bomber, F-22 advanced tactical aircraft, Strategic Defense Initiative, LHX helicopter, and V-22 Osprey are recent examples. Like their predecessors, these programs will only survive if the political climate supports their procurement. The difficulty in bridging the gap between technological jumps and implementation into the operational field is this often changing political climate.

Two basic questions determine this climate: Will the new technology contribute enough to justify its cost? And is there a more worthy technology competing for the same dollars? Complications arise when individual perspectives, viewpoints of key decision-makers, change during the course of the program.

The difficulty associated with implementing aggressive technology advancements into military inventory is illustrated by the attempts to acquire the North American B-70 bomber. This 30-year-old story shows how political climate, regardless of strategic mission requirements or technical maturation, determines the fate of innovative advancements in weapons systems. In the case of the B-70, inconsistent political support kept funding up and down for years, eventually killing the program.

By comparison, the B-2 bomber controversy almost pales. The B-70, and its derivative the RS-70, "...precipitated a fight so intense as to lead to a Constitutional crisis" (34:244). With billions of dollars at stake, the President and Congress were at odds year after year, finally resolving the dispute and dooming the program in a casual meeting in the White House Rose Garden.

DISCUSSION

Overview and Concept

The North American B-70 was "perhaps the most imaginative and sophisticated airplane ever designed" (42:30). Intended to replace the B-52 as the primary U.S. bomber, the B-70 was designed to fly continuously at Mach 3, at altitudes over 70,000 feet, and attack predetermined targets with nuclear bombs. The B-70 represented over 1000 patents and thousands of technical innovations. "She is so unlike previous aircraft that comparisons are almost meaningless," wrote Hunter (21:157).

The B-70's costs were as staggering as its performance. The average cost of a single B-70 (based on a 250 plane program) would be over $24.5 million, more than three times the cost of a B-52 it was replacing. Engineering and design costs were estimated at $1.3 billion.

The lifespan of the B-52 was not envisioned much beyond the late 1960s, and in the early 1950s, the Air Force began looking for a new, long-range bomber to become the nation's next strategic centerpiece. Progress seemed to indicate this next bomber would be a large, high flying supersonic aircraft, and certainly brought into the strategic inventory as soon as technology permitted.

Project Beginnings

In 1954, Air Force General Curtis E. LeMay, commander of the Strategic Air Command, officially defined mission requirements for a new, advanced jet bomber. His objective was a plane combining the range and payload of the B-52 with the supersonic speed of the B-58. The first design proposals did not meet LeMay's requirements and the contractors went back to the drawing boards.

In March 1956, a secret research paper by A.J. Eggers and C.A. Syvertson described an aerodynamic phenomenon called "compression lift," allowing a supersonic vehicle to increase lift by riding its own shock wave. This breakthrough made it both feasible and practical to fly at supersonic speeds for the entire mission, not just "dash" through the target area. North American Aviation discovered this paper during a routine periodical search and Eggers and Syvertson then collaborated with North American engineers and designers. Referring to compression lift, Dr Hugh L. Dryden stated "...a strange and wonderful thing happened. It was as if the pieces of a jig-saw puzzle began falling into place." (52:5)

In December 1957, North American's design for a Mach 3 intercontinental bomber (featuring compression lift) was selected over Boeing's. Boeing, whose B-17, B-29, B-47, and B-52 made them the recognized bomber experts, filed a protest over the decision. A special Congressional inquiry, however, found the decision sound. The principle factor of the decision to select North American's design was the com-pression lift feature.

One month after the selection, a contract was signed with North American for 12 test aircraft, plus a delivery of fifty bombers to SAC. The Air Force was planning for an eventual strength of 250 of the new bombers.

1958

In February 1958, the project was officially designated the B-70, with first flight due in Dec 1961, and SAC deliveries scheduled for 1964.

When the Eisenhower Administration cancelled the nuclear-powered aircraft program in 1958, the B-70 became the Air Force's only new bomber program. The Air Force therefore increased the priority of the program and accelerated its schedule by eighteen months.

Also that year, the Department of Defense Reorganization Act of 1958 was passed. This authorized the Secretary of Defense to "run the Pentagon." The Secretary could now assign the development, production, and operational use of weapon systems for any of the service branches. However, by custom, the services still dominated the policy and decision making in the significant areas. This legislation provided the groundwork for expanding the role of the Defense Secretary in the management of defense acquisition programs.

1959

In 1959 the B-70 first came under fire, and received a setback from which it would never recover.

President Eisenhower aimed at remaining militarily ahead of the Russians, but at the same time, operating within budgets that reflected the nation's economic status. Strategically, Eisenhower's position was to rely mainly on manned bombers, and remain cautious concerning intercontinental missile deployment. Even as missile technology matured, the country should maintain a "mix" of strategic systems, both bombers and ICBMs . But the ICBM was developing faster than expected , and the Defense Department found their ICBM

programs eating up such huge sums of money that new manned aircraft programs had to be critically reappraised.

In December 1959, a special Presidential study questioned the utility of the manned bomber compared to the ICBM. Since the U.S.S.R. was developing its own ICBMs, some considered the manned bomber obsolete; the Air Force could not possibly launch its fleet of bombers in time to avoid destruction by missile. Also, the U.S. ICBM programs had been making great progress, while the B-70, "...trying to revolutionize the bomber in one mighty leap, ran into predictable techno-logical snags" (35:32). Furthermore, the Cold War was experiencing a "thawing," marked by Soviet Premier Khrushchev's visit to the United States.

Realizing the country could not support every multi-billion dollar defense program in sight and stay solvent, the Administration made moves to terminate the B-70 program. The FY 1960 budget was trimmed by $25 million, and the FY 1961 budget was slashed from $365 million to only $75 million. This resulted in a trimmed and stretched out program, where only two experimental airplanes would be built. One airplane would be a prototype, designated XB-70, stripped of all complex bombing, navigation, and radar subsystems, and flight tested a year later than scheduled. The second aircraft, designated YB-70 and upgraded with the navigation and bombing equipment, would be flown a year later.

This move created an uproar among bomber proponents, who now saw only a bleak future for the program. Although officially only "trimmed and stretched out," many feared the program restructure would eventually kill the B-70 altogether. They believed when a B-70 prototype flew without vital subsystems the achievement would be "as hollow as its empty airframe," giving critics even more grounds to abolish the program because it obviously has not produced a truly useful vehicle. (19:21) Robert Hotz, editor of Aviation Week, called this move "...one of the most dangerous decisions made in this country during the past decade" (19:21).

Questions were raised regarding the overall future of the manned bomber. There were no longer any new programs on the horizon. The production lines for the B-52 and B-58 were scheduled to shut down altogether in 1962. Also, the Martin Company, proven and successful bomber manufacturers, abandoned manufacturing aircraft altogether .

President Eisenhower's cutback of the B-70 seemed to indicate a decision to eventually replace all manned strategic aircraft with ballistic missiles. As Eisenhower moved to make ICBM development the country's highest defense priority, the Air Force's highest priority programs were still additional B-52s and the B-70. The Air Force was reluctant to adopt a missile based strategy because "the bomber represented the heart of the Air Force's guiding military doctrine, the overriding importance of strategic air power" (35:32).

At the Pentagon, in the Air Force, and in Congress, lines were drawn between advocates of manned bombers and missiles.

1960

The B-70 quickly developed into one of the most controversial weapons issues ever. Legislators, who had substantial aviation industry in their home states, led in the attack upon the B-70 cutbacks .

The politics now commonly associated with large scale defense programs were just emerging in 1960, as the size of military projects was increasing. Replacing the several hundred B-52s with B-70s promised to be at least a $6 billion effort.

In 1959, Congress passed Public Law 86-149, which increased their control over

acquisition of large defense programs. Congress passed additional legislation in 1960 which gave the House and Senate Armed Services Committees (HASC and SASC) increased influence in the annual defense budget. Prior to 1960, the Committees only authorized funding for military construction projects. But recognizing the growing size of appropriations for ships, aircraft, and missiles, the Committee members succeeded in working legislation that permitted them authorization of these programs as well. "With contracts involving billions of dollars, the fate of entire companies, the economic welfare of communities, and the careers of ambitious politicians all hinged on winning key defense projects." (35:50)

Early in 1960, the Senate conducted its own investigation into the need for the new bomber, chaired by Senator Lyndon Johnson. General Thomas S. White, Air Force Chief of Staff, testified against the Administration's cutback of the program. Air Force General Nathan Twining, Chairman of the Joint Chiefs of Staff, testified that if the B-70 was not procured, the United States would have no bombers in 1967, due to rapid advances in bomber technology making the B-52 and B-58 obsolete. General LeMay argued that ballistic missiles could not serve all the needs of deterrence and security. Rather, he believed manned bombers together with ICBMs, would be necessary. "Our problem is not one of killing our opponents, LeMay testified, "Our problem is one to keep our opponents from killing Americans and our allies.... If we just want to kill our opponents, that is a very simple problem. It calls for a lot less weapons ...."(58:132)

The ability of an aircraft to even penetrate Soviet airspace fell under scrutiny in mid 1960. During the late 1950s, Americans believed the Soviets had no surface-to-air missile (SAM) nor interceptor aircraft capable of reaching an aircraft at 80,000 ft altitud. However, on May 1, 1960, Soviet SAMs brought down a U-2 reconnaissance aircraft overflying the USSR, while it was near this altitude. The celebrated Francis Gary Powers U-2 "spy incident" caused a reevaluation of the B-70's vulnerability to radar detection and SAMs. Critics argued that the airplane's skin friction at Mach 3 would make an easy target for a heat seeking missile, and the bomber's size would be easily picked up on radar. Some foresaw an impenetrable Soviet Union by the years the B-70 was scheduled to become operational. But advocates of the B-70 used the Soviet defenses for their own arguments. Experts estimated it would cost over $40 billion for the Russians to upgrade their defenses to counter the $10 billion B-70 . Many agreed with Ed Rees, who wrote, "If the B-70 accomplished nothing else but obligated the Soviets to a $40 billion defense expenditure, an expenditure that would not increase her offensive strength against the United States homeland by one warhead, it will have proved a superb tradeoff." (54:61)

In July 1960, Johnson's Preparedness Investigating Sub-Committee of the Senate Armed Services Committee released their findings. They concluded there was a vital necessity for a new intercontinental bomber, despite ICBM development. Furthermore, the nation possessed the resources and technology necessary to build the B - 7 0 . Finally, experience showed that stretching out a program only increased costs and wasted valuable time.

With the B-70 need reaffirmed, Congress restored its funds, and also voted $184 million more than the President's budget called for. Although Congress authorized additional funds for the plane, there was nothing requiring the President to so spend it. "Congress appropriates military funds based on DoD requests, and then the DoD reallocates as it wills," wrote Pike

(47:1058). This allowed the Executive Branch to "impound," or simply not spend, any funds it considered excessive. (This was not the first time this issue had arisen. In 1949, the Truman Administration had impounded $615 million appropriated by Congress for the purchase of airplanes.) These controversial procurement powers of the Legislative vs. the Executive Branches would haunt the B-70 program for years to come.

Meanwhile, as Congress was investigating the need for the B-70, the issue had also become an important item in the 1960 Presidential campaign. John F. Kennedy, was campaigning in California in support of the airplane, which would provide jobs at the North American manufacturing plant.

Although President Eisenhower was against pursuing the B-70 as a full weapons system, he released $155 million in additional funds the very day before the election. His reason for releasing the money "at the height of the uproar" was that the U.S. was taking a series of steps to cope with the Soviet actions following the May U-2 affair. However, others saw its timing as a last minute attempt to win California votes for Republican candidate Richard M. Nixon.

The $155 million again restructured the program such that now one XB-70 and two YB-70s would be built, followed by twelve fully operational B-70s.

Although the B-70 had played an important role in the election, with the victorious Democrats strongly advocating the new bomber, within a month of taking office, the Kennedy Administration dropped its plans to revive the B-70.

<u>1961</u>

In January 1961, as part of his final State of the Union Message to the Congress, outgoing President Eisenhower stated, "the bomber gap of several years ago was always a fiction..." (67:14). Secret U-2 reconnaissance photographs had revealed that the U.S. was actually far ahead in bomber production. As the new Administration was given access to these facts, the future of the B-70 program once again was in doubt.

Although the Department of Defense Reorganization Act of 1958 increased the authority of the Defense Secretary, it was not until 1961 that the was fully exercised. New Secretary of Defense Robert S. McNamara believed in active management, and with the authority vested in the office, he played a major role in weapon acquisitions.

The Administration compared the cost and effectiveness of the B-70 to other weapons systems. McNamara believed in selecting a weapon systems by "...dealing not with absolutes but with comparatives" (58:40). According to McNamara, "We must always take into account not only the planned capabilities of the proposed weapon system, but also its full cost in comparison to the cost and effectiveness of other weapon systems which can do the same job, perhaps in somewhat different ways." (58:40)

McNamara also questioned the Air Force position that the B-52 would be obsolete by the late 1960s. He believed the plane could be used into the 1970s, using stand-off weapons, thus eliminating the need to penetrate Soviet airspace. (37)

Furthermore, McNamara questioned the technical feasibility of the airplane's role as the Air Force described it. At 80,000 feet, traveling at Mach 3, the B-70 would indeed be a "manned missile," incapable of finding mobile or hidden targets; limited to predetermined targets of known position. The B-70 appeared to lack the flexibility generally attributed to manned bombers. Finally, McNamara believed the high flying, supersonic B-70 would be more easily

detected by Soviet radar than the current B-52.

In March 1961, President Kennedy released an official statement that America's forthcoming ICBM capability "...makes unnecessary and economically unjustifiable the development of the B-70 as a full weapons system...." (46:20). The Administration received heavy criticism for this decision, since Kennedy had supported the B-70 during campaigning, and Vice-President Johnson had chaired the Senate Investigation that had urged its full production.

Secretary of Defense McNamara's plan for the B-70 now reduced it to four prototype airplanes designed to investigate problems of long-range operations at prolonged supersonic speed. The Eisenhower budget for FY 1962 was trimmed to $220 million, less than half the Air Force requirement.

During the spring of 1961, the Air Force again sought to reinstate B-70 funding by going before the Congress. Secretary of the Air Force Eugene Zuckert warned Congress that reliability of ICBM systems had not yet been proven. Defense Secretary McNamara, testified he was against any acceleration of the B-70 program, and stated he would refuse to spend any additional funds above the President's budget.

The House and Senate Armed Services Committees concurred with the Administration's plans and appropriated only $220 million, refusing pleas from the Air Force to increase funding and develop the B-70 as a full weapons system. House Armed Services Committee Chairman Carl Vinson agreed that the President's plan allowed for an orderly development of the aircraft -- providing an opportunity to test the technical feasibility of the B-70 and its related subsystems while also preserving an option of full production if it proved necessary. When the defense budget went to the Appropriations Committees, for the first time in 25 years it did not include any funds for production bomber buys.

However, before the final appropriations were passed, two important events took place. First, East/West tension increased drastically as situations in Berlin worsened. In August, the Berlin Wall was constructed through the city, dividing it between East and West. Fears grew that there would be a U.S./Soviet military showdown.

Second, and probably more significantly, was the Soviet Airshow at the Tushino Airfield. Following their recent achievement of putting the first man in space (Yuri Gagarin, April 1961) this airshow was designed to show that Russia was unquestionably the world leader in aerospace technology. The Soviets proudly paraded their latest achievements in military aircraft. Among the aircraft demonstrated was a Mach 2.5 medium bomber larger than the B-58, and a giant supersonic heavy bomber (NATO code-named Blinder and Bounder, respectively). Several key members of Congress became convinced that the U.S. must increase spending for bomber programs in order to stay abreast of the aircraft developments demonstrated at Tushino.

As a result of this apparent Soviet military buildup in bomber aircraft and the Berlin crisis, increased appropriations were introduced in Congress. General LeMay, now Air Force Chief of Staff, was once again called upon to testify. Regarding the B-70, he asked for an additional $200 million for 1962 funds, and $500 million for the following year. After the hearings, the House Committee stated the Defense Department was not wise in cancelling production of the B-58 and B-52 bombers, while at the same time restricting the development of the B-70. They also stated the first use of available funds should go towards accelerating the B-70 program.

Meanwhile, the Administration was also looking at the defense budget situation. On July 31, President Kennedy formally asked Congress to increase the defense funds for several programs, but not for any bomber programs.

Congress approved the President's requests, and went one step farther. The defense budget would include an additional $180 million for the B-70, and also voted over $500 million for continuation of the B-52 and B-58 production lines.

Based upon Congress' insistence on funding the B-70, Defense Secretary McNamara undertook another investigation into the program. In January of 1962, McNamara testified before the House Armed Services Committee, stating, "We have again restudied the role of the B-70 in our future strategic retaliatory forces and again have reached the conclusion that the B-70 will not provide enough of an increase in our offensive capabilities to justify its very high cost...."(9:373)

Despite the warnings that he was defying the wishes of Congress and ignoring the requirements of the Air Force, McNamara announced that he would again impound the additional B-70 funds authorized by Congress, as well as the funds for further bomber production.

1962

Robert McNamara's refusal to spend the appropriated bomber funds infuriated many important members of Congress. It seemed likely that some sort of showdown would occur between the Defense Department and the Legislature when the B-70 program was brought before Congress for the FY 1963 budget.

With the prospects of the B-70 bomber ever replacing the B-52 as the SAC mainstay looking bleak, the Air Force worked with North American Aviation to develop additional capabilities. Added capabilities and flexibility would hopefully interest the Administration.

In 1962, the Air Force proposed the new project: a reconnaissance-strike version of the aircraft, designated the RS-70. The RS-70 was designed to overfly and scan the enemy territory during or after a nuclear exchange, identifying and attacking any targets not destroyed by the first salvo of missiles. By processing reconnaissance data within an airborne strike vehicle, targets could be immediately attacked, instead of wasting precious time waiting for the next round of missiles. Advanced computerized radar would direct airborne missiles to their targets. The Air Force and North American were proposing a program of 60 operational aircraft by 1969, at an estimated cost of $50 million each, with another 150 airplanes delivered in 1970. For this RS-70, the Air Force's FY 1963 request totaled $573.8 million, compared to only $171 million allocated according to the President's budget.

The Administration did not support the new and improved B-70. First of all, Robert McNamara did not believe the technology required for such a mission existed. He argued that as the RS-70 flew at 70,000 feet and 2,000 miles per hour, the proposed radar would be seeing new areas at a rate of 750 million square feet per second. The technology required to gather, process, and display this data would not be available by the time the RS-70 required it.

Second, even if it was feasible, what overall contribution would the RS-70 make? In its intended mission, the RS-70 would be hunting for the last few surviving and unlaunched Soviet missile sites. The importance of overflying Soviet targets looking for residual weapons, after each country had already exchanged several thousand megatons of nuclear firepower was compared to the several billion dollars of national resources required.

In February, General LeMay went to Capitol Hill to present his case for pursuing the RS-70. Although the House and Senate Armed Services Committees had agreed with the President's "cut-back" B-70 program the previous year, this time they would side with the Air Force.

The House Armed Services Committee was chaired by eighty-four year old Carl Vinson of Georgia. Vinson had served in Congress forty-eight years, longer than any other member. Through seniority, he had amassed great political instinct and power. He was known as the "Swamp Fox" for his cunning and slyness, and "Admiral Vinson" for his strong control of defense programs. Vinson agreed with McNamara's that much of the equipment for the RS-70 had yet to be developed. In fact, he used it as an argument to fund the project. "It is for this very reason that we need the larger program for the RS-70," Vinson said on the House floor. He was concerned that the manned bomber, the only proven strategic weapon, appeared to be the most neglected weapon in the arsenal. Although he was angry at the President's decision to de-emphasize the manned bomber role, his real crusade concerned the President's Constitutional authority to do so.

Vinson had agreed with the President's B-70 plan just the previous year. However, he was now concerned about the eroding powers of the Legislative Branch. "To any student of government," his Committee report stated, "it is eminently clear that the role of the Congress in determining national policy has deteriorated over the years" (39:19). The previous year, Congress had added over $700 million for B-70, B-52, and B-58 procurement, and "...not one penny has been spent." Using the RS-70, Vinson now sought to address "...a question more fundamental than whether this weapon system or any other should be adopted as a part of our military establishment" (39:1).

Vinson's House Armed Services Committee authorized the President's requested $171 million, then voted an additional $320 million. Furthermore, the Committee's appropriation "directed, ordered, mandated, and required" the Air Force Secretary to spend the money and accelerate the RS-70 program. The Committee report stated: "If this language constitutes a test as to whether Congress has the power to so mandate, let the test be made and let this important weapons system be the field of trial. Perhaps this is the time to reexamine the role and function of Congress, and discover whether it is playing the part that the Founding Fathers ordained that it should. " (39:19)

Constitutional experts believed the Executive Branch would win Vinson's challenge if it went to the courts. But President Kennedy wanted to avoid a fight. Any tangle with Vinson and the Congress, win or lose, would be costly in the future.

On March 1, Vinson's directive was approved unanimously by the Committee, and would be voted on later by the entire House. But Carl Vinson's challenge angered some other members of Congress. Members of the House Appropriations Committee believed their committee dictated how funds were to be spent. They felt Vinson's committee was exceeding its proper role, and doing so at the expense of the Appropriations Committee.

On the eve of the House vote, a meeting took place at the White House. President Kennedy had invited Carl Vinson for a personal chat in the Rose Garden.

The President and Carl Vinson stated their views and rationale, and both maintained their respective, inflexible positions. Kennedy stated the country didn't need the RS-70, and as Commander in Chief, he would not spend the money.

Vinson responded saying the country did need the RS-70, and Congress Constitutionally had the power to equip the armies, and could therefore order the expenditure of funds. (37)

Both President Kennedy and Vinson recognized there was no way to resolve the conflict other than litigation before the Supreme Court. Furthermore, they both believed that resolving this type of conflict between two equivalent branches of the Government was not the intended function of that court. Vinson agreed they should not confront the court with this issue, and agreed to withdraw the language "directing" the spending of funds. "I led those troops up that hill, and by God, I'll turn them around and lead them down!" Vinson promised (37). In exchange, the Defense Department would initiate an immediate reinvestigation of the necessity for the RS-70/B-70. Under the agreement, the President would spend more on the RS-70 program if this new review warranted an increase. Furthermore, if technological developments advanced faster than expected, the Administration would request and expend larger funds.

The following day, the Armed Services Committee removed the controversial language from the ammendment. Once the President had reaffirmed his power to withhold appropriated funds, there remained practically no possibility of expanding the RS-70 program.

This appeared to be a big victory for the President. The Administration's promise to restudy the program was essentially "...a promise of no value, for Defense Secretary McNamara had been studying the RS-70 from the time he had taken office, and his only conclusion had been that the whole program should be cut back and probably killed" (43:296). Vinson, on the other hand, saw it as a victory for Congress. He told the House he had not intended to push the fight to a Constitutional showdown, but rather force the Pentagon to respect and respond to Congressional actions. Meanwhile, President Kennedy stated at a press conference that neither side had won or lost. "The country was the winner," he said, "because such a conflict had been averted" (3:1).

1963

Robert McNamara had appointed Dr. Joseph V. Charyk, Undersecretary of the Air Force, to conduct the RS-70 restudy. In January, McNamara went before the House Armed Services Committee with the results. He opened by stating the issue was not the future of manned bombers in an era of missiles. Instead, it was whether the B-70/RS-70 would add enough to the country's strategic strength to justify its high cost.

The review did not justify an accelerated RS-70 program, but McNamara stated he would spend $50 million of the extra appropriations to further develop sensor components. The RS-70 remained programmed for three test aircraft.

In February, General LeMay returned to the House Armed Services Committee and resumed his battle for the RS-70. LeMay stated he was not opposed to missiles; however, he felt the flexibility of a manned bomber force was essential. He asked for an expansion of the program to five aircraft instead of the three currently programmed for. The Committee concurred with LeMay's arguments, calling the Defense Department's increasing emphasis on missiles over bombers "...a most dangerous course of action..." (9:411).

Committees in both the House and Senate approved $364 million above the President's budget for the RS-70 program. This expansion would increase the program from three to five aircraft, with the last two upgraded with full RS-70 reconnaissance features.

In California, the first XB-70 aircraft encountered significant technical problems. Severe corrosion occurred between different grades of stainless steel and other materials in the airframe. Also, North American found difficulty sealing microscopic holes in the fuel cells. These problems were delaying the plane's first flight well into 1964.

Meanwhile, the Administration and SAC were now considering concepts for a different bomber which would satisfy McNamara's criticisms of the B-70. It would penetrate Soviet air defenses by flying at low altitudes, under the radar networks.

In May, Robert McNamara announced plans to cancel the RS-70 program outright. In light of the new National SST project and assurance that another advanced bomber program was in work, the Congress was now willing to concede. The RS-70's main advocate in Congress was no longer able to rally his fellow representatives for his cause. Carl Vinson had made a number of enemies in the House. He had strongly endorsed an enlarged and more powerful House Rules Committee in 1962, a move that turned many of his House supporters against him. Combined with his earlier controversial operations of the Armed Services Committee, his power in the House was diminishing. (Later that year, Carl Vinson announced that after fifty years in the U.S. House of Representatives, he would not seek reelection.) Against the Swamp Fox's recommendations, the House reversed its decision and withdrew $314.3 million allocated for expanding the RS-70 program.

Aviation Week announced on July 1, 1963 that the battle between McNamara and Congress over the B-70/RS-70 was finally over, with McNamara victorious (57:25). "Political background of the near-unanimous RS-70 vote was a desire by many conservatives in Congress to get even with Chairman Carl Vinson.... Representative Vinson could rally so few votes that he went out of town rather than witness certain defeat...." (57:25)

The RS-70 project was scrapped, and the B-70 concept was reduced to two XB-70 airplanes.

1964

On May 11, 1964 the first XB-70 aircraft was rolled out of its Palmdale, California hangar. Since the program cost $1.5 billion and produced only two test airplanes, the rollout was "visible evidence of a humiliating defeat for the bomber men" (22:90). As Newsweek described the situation: "The first public showing of the 2000 mph B-70 would seem a triumphant moment for the Air Force's big-bomber men and their friends in Congress. For five years they doggedly fought first Eisenhower and then Kennedy Administration efforts to kill the giant delta-winged superbomber as an unneeded frill in the age of missilery. Yet neither Air Force Chief of Staff Gen Curtis LeMay, HASC Chairman Carl Vinson, nor a host of their vociferous B-70 backers even planned to visit ... this week when the first B-70 was scheduled to be rolled out. The California rollout shaped up as more of a wake than a celebration." (22:90-91)

CONCLUSIONS

Contrary to various authors' theories and allegations, the B-70 program was not cancelled because of Soviet air defenses (48:24 & 4:182), or secretly deferring funds to the A-11/YF-12 program (46:22). Nor was cancellation based on actual flight performance. The B-70 fell victim early in development to lack of political support. The government chose to allocate scarce dollars to ICBM development rather than a supersonic bomber whose overall

contribution to strategic mission was questionable. Except for $155 million restored to the program in 1960, the Executive Branch never endorsed the program. The Congress, a much stronger advocate, still was inconsistent from year to year in its support. The ultimate confrontation between the two government bodies ended with the Congress backing down in the Rose Garden meeting.

This meeting stands as a critical event in the history of defense system acquisition. Vinson's challenge would have settled (either by judicial resolution or by political precedent) the Constitutional law issue of Executive discretionary power versus Legislative mandate over defense dollars. In other words, does the Legislature require or permit the Executive to spend defense funds? This, in turn, might have begun an adversarial relationship between President Kennedy's Administration and the Congress. Had Vinson and the Congress pursued this challenge, the B-70 bomber program may have been expanded, eventually reaching full production. Instead, this meeting was a crushing blow to hopes of resurrecting the aircraft as a weapons system.

For a technologically advanced weapon system to become part of the operational military inventory, the political climate must support its development and procurement. Competing technologies can bleed funding away, and eventual benefits must support the high costs likely associated with the system's development and production. Without the consistent support of the political environment, advances in military weaponry can not cross over from innovative concepts to operational systems.

Bibliography

1. "Air Force Pares B-70 Plan to Bone," New York Times, 108: 22 (2 December 1959).

2. "B-70 Program Gets Refueled by $155 Million," Air Force Times, 21: 18 (5 November 1960).

3. Baker, Russell. "B-70 Dispute Ends as Vinson Yields on Fund Demand," New York Times, 111: 1 (22 March 1962).

4. Barron, John. MiG Pilot. New York: Reader's Digest Association, Inc., 1980.

5. "Battle Lines Drawn in B-70 Issue: President vs. Legislators-Military," Air Force Times, 20: 17 (30 January 1960).

6. Butz, J. S., Jr. "Budget Cuts Force Stretchout of B-70," Aviation Week and Space Technology, 71: 26-28 (7 December 1959).

7. "Chemical Bomber," Time, 71: 13 (6 January 1958).

8. Cockburn, Andrew. The Threat; Inside the Soviet Military Machine. New York: Random House, 1983.

9. Coffey, Thomas M. Iron Eagle. New York: Crown Publishers, 1986.

10. Collender, Stanley E. The Guide to the Federal Budget. Washington, D.C.: Urban Institute, 1990.

11. Cook, Lt Col Curtis R. Department Head, Systems Acquisition Management, School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB OH, Personal Interview, WPAFB OH, 19 July 1990.

12. D'Angelo, Anthony P. "Federal Financial Management and Budgeting Systems," Readings in AMGT 602, Federal Financial Management. School of Systems and Logistics, Air Force Institute of Technology (AU), WPAFB OH, 9 July 1990.

13. "Death Knell for RS-70," Aviation Week and Space Technology, 78: 25 (13 May 1963).

14. Emory, C. William. Business Research Methods (Third Edition). Homewood IL: Irwin, Inc. 1985.

15. Enthoven, Alain C. and K. Wayne Smith. How Much is Enough? New York: Harper and Row, Publishers, Inc. 1971.

16. Fox, J. Ronald and James L. Field. The Defense Management Challenge: Weapons Acquisition. Boston: Harvard Business School Press, 1988.

17. "Gallery of USAF Weapons," Air Force Magazine, 43: 234-235 (September 1960).

18. Gray, Wood. Historian's Handbook. Boston: Houghton Mifflin Company. 1964.

19. Hotz, Robert. "A Dangerous Decision," Aviation Week and Space Technology, 71: 21 (7 December 1959).

20. -----. "Thorns in the Rose Garden," Aviation Week and Space Technology, 76: 18 (26 March 1962).

21. Hunter, Mel. Strategic Air Command. New York: Doubleday & Co. 1961.

22. "Humiliating Triumph," Newsweek, 63: 90-91 (18 May 1964).

23. Jane's All the World's Aircraft 1982-83. London: Jane's Publishing Company, 1982.

24. Jane's All the World's Aircraft 1963-64. London: Jane's Publishing Company, 1983.

25. Johnsen, Katherine. "Bomber Funds Win Early Approval," Aviation Week and Space Technology, 80: 26-27 (24 February 1964).

26. -----. "Congress Agrees on $362 Million for RS-70," Aviation Week and Space Technology, 77: 16 (30 July 1962).

27. -----. "House Committee Adds Bombers to Budget," Aviation Week and Space Technology, 74: 26 (8 May 1961).

28. -----. "House Unit Approves Extra RS-70 Money," Aviation Week and Space Technology, 78: 24 (4 March 1963).

29. -----. "House Votes Bomber Increase," Aviation Week and Space Technology, 75: 26-7 (3 July 1961).

30. -----. "Senate Group Joins Bomber Drive," Aviation Week and Space Technology, 74. 27 (15 May 1961).

31. -----. "Senate Votes $363.7 Million Extra for RS-70," Aviation Week and Space Technology, 78: 26 (22 April 1963).

32. -----. "Senate Votes Full RS-70 Funds," Aviation Week and Space Technology, 76: 29 (18 June 1962).

33. -----. "USAF Opens Congressional Drive for B-70," Aviation Week and Space Technology, 74: 32 (17 April 1961).

34. Kaufman, William W. The McNamara Strategy. New York: Harper and Row Publishers, 1964.

35. Kotz, Nick. Wild Blue Yonder. New York: Pantheon Books, 1988.

36. "Last B-36 is Grounded," New York Times, 108: 55 (13 February 1959).

37. McNamara, Robert S., Secretary of Defense 1961-1968. Personal Interview. Washington D.C., 23 March 1990.

38. McNamara, Robert S. The Essence of Security. New York: Harper and Row Publishers, 1968.

39. "McNamara Wary on B-70 Conflict," New York Times, 111: 1,19 (9 March 1962).

40. "McNamara Views Strategic Aircraft Role," Aviation Week and Space Technology, 78: 67-71 (11 February 1963).

41. "Milestones," Time, 117: 58 (15 June 1981).

42. Miller, Jay. "B-70 Fails to Perform," Air Force Times 41: 20 (29 December 1980).

43. Mollenhoff, Clark R. The Pentagon. New York: G.P. Putnam's Sons, 1967.

44. Moon, Howard. Soviet SST: the Technopolitics of the Tupolev-144. New York: Orion Books, 1989.

45. Neustadt, Richard E. and Ernest R. May. Thinking in Time. New York: Free Press, 1986.

46. Pace, Steve. North American Valkyrie XB-70A. Blue Ridge Summit PA: Aero Publishers, 1984.

47. Pike, Iain. "B-70: State-of-the-Art Improver," Flight International, 85: 1055-1062 (25 June 1964).

48. Polmar, Norman. Strategic Weapons. New York: Crane, Russak and Company, 1982.

49. Powers, Francis Gary and Curt Gentry. Operation Overflight. New York: Tower Publications, 1970.

50. "Premier of the North American XB-70A," Interavia, 19: 982-984 (July 1964).

51. Raymond, Jack. "Air Chief Scores B-70 Cut," New York Times, 109: 1 (12 January 1960).

52. -----. "B-70 Stirs a Wide Ranging Controversy," New York Times. 111: 5 (11 March 1962).

53. -----. "Johnson Reveals a 2,000 mph Jet," New York Times. 113: 1 (1 March 1964).

54. Rees, Ed. The Manned Missile. New York: Duell, Sloan, and Pearce, 1960.

55. Rich, Ben, Executive Vice President and General Manager, Advanced Development Projects, Lockheed Aeronautical Systems Company. "Skunk Works." Address to AFIT students. Air Force Institute of Technology (AU), Wright-Patterson AFB OH, 20 July 1990.

56. Roherty, James M. Decisions of Robert S. McNamara. Coral Gables FL: University of Miami Press, 1970.

57. "RS-70 Victor: McNamara," Aviation Week and Space Technology, 79: 25 (1 July 1963).

58. Screws, Lt Col Charles B. An Analysis of the Defense Position on Manned Strategic Vehicles. Thesis, Air War College, Maxwell AFB AL, 1965 (M-32983-NC).

59. "Senate Preparedness Committee Urges B-70 Development," Army, Navy, Air Force Journal, 97: 3 (16 July 1960).

60. Sorenson, Theodore. Kennedy. New York: Publishers Inc., 1965

61. Spaatz, Gen Carl. "The Case for the B-70 in an Age of Missiles," Newsweek, 57: 34 (17 April 1961).

62. Stein, Harold. American Civil-Military Decisions. Birmingham: University of Alabama Press, 1963.

63. Stewart, Jim. "B-2 Emerges as a Symbol of New Budget Dilemmas," Dayton Daily News, 113: 4 (12 April 1990).

64. "Swamp Fox at Eighty," New York Times, 112: 19 (19 November 1963).

65. Swisher, Robert R. and Charles R. McClure. Research for Decision Making. Chicago: American Library Association, 1984.

66. Taylor, John W.R. "Gallery of Soviet Aerospace Weapons," Air Force Magazine, 73: 74 (March 1990).

67. "Text of Eisenhower's Final State of the Union Message," New York Times, 110: 14 (13 January 1961).

68. "Top Secret Chemical Bomber," Science Newsletter, 72: 195 (28 September 1957).

69. Tosti, Col C. "Does the USAF Need the Mach 3 Bomber?" Interavia, 16: 800-802 (June 1961).

70. Trewhitt, Henry L. McNamara. New York: Harper and Row Publisners, Inc. 1971

71. "T/Sgt Seiler Wins $500 for Naming B-70 Valkyrie," Army Navy Air Force Journal, 95: 11 (5 July 1958).

72. Witze, Claude. "Trial By Press Conference," Air Force Magazine, 45: 16-20 (April 1962).

73. Wilson, George C. "Defense Budget Approved," Aviation Week and Space Technology, 75: 30 (14 August 1961).

74. -----. "Kennedy Asks More Aircraft, Missile Funds," Aviation Week and Space Technology, 75: 22-3 (31 July 1961).

75. -----. "Senate Moves Toward More Bomber Funds," Aviation Week and Space Technology, 75: 32-3 (24 July 1961).

76. Zuckert, Eugene. "The Service Secretary: Has He a Useful Role?" Foreign Affairs, 66: 458-472 (April 1966).

RESEARCH CONCERNING PROGRAM MANAGEMENT PRINCIPLES

John J. Bennett, DBA, ANADAC, Inc.

INTRODUCTION

General system theory is considered a management discipline by most management specialists. As a discipline, general systems theory provides a body of knowledge, a set of basic concepts, and supporting management principles. Program and project management, as practiced in managing major weapon systems and similar developments can be considered variants of general systems theory.

The (general) system management practices in use by the Federal Government and the aerospace/defense industry have been evolving since shortly after World War II. The Defense Systems Management College (DSMC) has been the Department of Defense (DoD) center of excellence for DoD program management education and knowledge. DSMC first started training program managers in 1972. Over the years its training documentation has undergone continuous research and updating to interpret program management policy, specify functional details, identify practices and procedures and provide methods and techniques. Today, there are very few who would disagree that the DSMC body of knowledge is an acceptable standard for defining program management as a unique discipline.

In review of overall DSMC documentation and discussion with DSMC staff, one finds that for the most part, the DSMC body of knowledge is defined, in general, by a set of functional entities (e.g., engineering, contracting, etc.) and supporting management practices. If one compares this with a notional structure for defining management disciplines as in Figure 1, a question is raised as to how basic concepts and management principles individually and collectively interact in the DSMC structure.

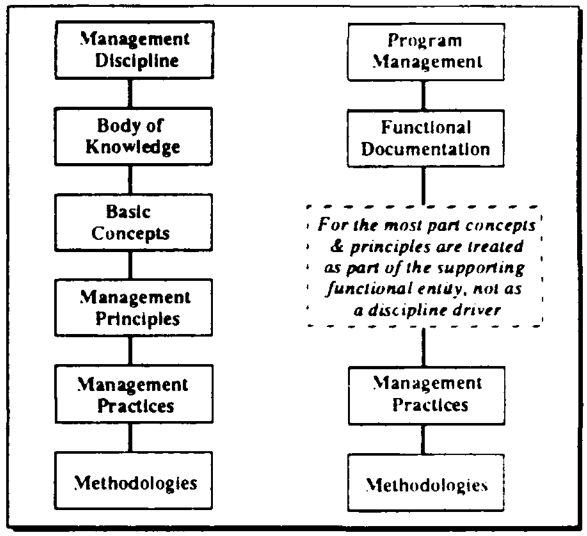


Figure 1. Program Management Knowledge Structure Compared to a Notional Basis for Defining Disciplines

While acknowledging the value of the present DSMC body of knowledge and its structure, a question can be raised as to whether an explicit set of program management concepts and principles can be defined and whether these would contribute to increasing professionalism and improvements in education and training. Accepting the general system or systems management concepts as a foundation, the research can be narrowed to the definition of management principles.

THE RESEARCH DATA BASE

The purpose of the research is to define a set of unique management principles that would simplify the structural basis for

program management and provide more clarity of the program management fundamentals. It was thought that this simplification and clarity would be most useful as the basis for a training manual for staff members directly related to program management such as contract specialists and budget analysts.

The DSMC series of technical training manuals (e.g., the Systems Engineering Management Guide) and other substantive DSMC publications were used as the data base for this research. These were augmented by a review of management articles from DSMC's Project Manager and NCMA's Contract Management magazines dating from 1982 onward.

The writer attempted to synthesize this data around program management themes (e.g., designing in quality) and the tasks required to accomplish that theme (e.g., structuring program test and evaluation). The management principles postulated and highlights of the rationale used in making the selections are discussed below.

MANAGEMENT PRINCIPLES

Of the management principles selected several are generally accepted as such today (e.g., single authority and responsibility). Others are implied by wide use (e.g., life cycle management). A third category of selected principles are those that will need to be debated and probably recast and refined. Ten principles are stipulated for discussion.

1. Integration

Integration is the principle of bringing together heterogeneous disciplines, organizations, functions, processes, technologies, data and/or information, both vertically (organizations, functions, skills, budgets, etc.) and horizontally (processes, procedures, events, activities, etc.) to effectively and efficiently manage a program. Program integration is the basis for synchronizing the resources and program work to be performed.

o Rationale. The theme of wholeness permeates and drives acquisition program management. Integration of complex and costly development over a long period of time is the premium task of the project manager. The program manager is continually faced with the integration of changing project office functions and skills, as the product life cycle changes. The program manager must oversee the integration of multi-purpose processes pertaining to organizing and executing the work, the integration of evolving product technical documentation and physical systems and subsystems, and the synthesis and integration of both technical and management information. Management systems integration provides the structure for program management and the program. Methods and procedures are available to address each of the integration tasks.

2. Single Authority and Responsibility

The single authority principal vests program management decision-making, coordinating and supervision in a single individual, limited only by pre-stated corporate constraints and the necessary chartering, organization and plans to do this. The primary benefit of a program management organization is in providing a focal point for authority, responsibility, coordination, and ultimately accountability for the success of the program.

o Rationale. Federal Government policy stipulates single authority and responsibility as an aspect of its acquisition

management policy. A decision to apply program management concepts within a Government or corporate entity will in almost every case have a major impact on the corporate organization, and its delegation of authority and responsibility. While a number of people feel recent pronouncements restrict program managers to the exercise of influence over the programs and events, it can be pointed out that acting as the program coordinator is a central and an important task. Program authority and responsibility dictates communication channels, funding and contracting arrangements, and the oversight of engineering and development. Sufficient documentation and methods are available to address all of these considerations. Note that human behavior aspects are not currently part of this or other definitions herein.

3. Life Cycle Management

The life cycle management principle provides the structure for managing the program process and sub-processes from inception of an idea through disposal or replacement of a product after its useful life expires. Process management methods are used to identify and resolve functional life cycle interfaces and interdependencies, as necessary, to tailor the product life cycle.

o Rationale. Life cycle management implement one aspect of program integration in that it provides the documentation and visible program structure. Each common product (e.g., weapon, space, energy, computer, information system or facilities) has a common life cycle. These common life cycles have natural phases they follow with only slight deviation. Process management methods are used to analyze both the product and functional life cycles to identify the inter-relationship between the overall program/functional events and activities. Multi-functional interfaces and interdependencies are identified and related problems resolved. This results in a program "road map" which serves as the program master schedule. Further process analyses identifies the work to be accomplished and physical processes. The physical product technical documentation results in a father/son work breakdown structure (WBS). These structures -- master schedule, work to be accomplished and WBS -- as a composite, are part of and form the basis for life cycle management. The composite structure and data can be subjected to cost analysis to estimate not only the development but also the production, operation and support costs (i.e., the life cycle costs).

4. Pre-Specified Objectives

The principle of pre-specified objectives requires early on and specific planning to identify explicit technical and business requirements, program strategy and risks. Requirements for change or new capability in the form of plans must be well documented. A strategy stating how the system or product will be acquired must be formulated. Program risks must be identified and reduced to acceptable levels prior to development.

o Rationale. The central theme of program management action is to bring about change, and generally in the form of a new or modified material item or thing (e.g., a system or product). The desired change is stated by setting forth pre-determined objectives for the item. A requirement for a new or improved system or product can be generated by the threat of an adversary or competition, advances in technology, the need to modernize or

upgrade a system or product, or expected improvement in the return on investment. As the concept formulation proceeds, alternate concepts are identified and explored to satisfy the pre-stated requirements (i.e., needs). An acquisition strategy becomes part of the planning to guide the program and emphasize transition into verification and demonstration of a preliminary technical design. Many times this is supported by a demonstration prototype. A program baseline (plan) is defined as a formal agreement between essential program participants (e.g., program manager, corporate staff, and the board of directors). These specified critical parameters of a program that must be fulfilled before entering development or production. Methods and procedures are available to execute each of these tasks.

5. Design as Key Quality Factor

The principle of designing-in quality requires a total perspective of customer requirements, consideration of alternative solutions and trade-offs, addressing manufacturing and logistics factors in design, and balancing cost and performance with customer satisfaction. The design should represent the best trade-off among the competing life cycle requirements, including reliability and maintainability, producibility, life cycle and design-to-cost, and operations and support factors.

o Rationale. Product or system design is one part of the systems engineering process and is a common technical thread that runs through the program management life cycle process. The product design should represent the best trade-off among the competing life cycle cost/performance requirements. Optimization of the design trade-off process is the initial basis for designing in quality and carries throughout the engineering cycle. Top level specifications are further refined through iterative analysis and scale testing and extended at various levels to include analyses of technical considerations ranging from human factors to power sources. Designing in reliability and maintainability (R&M) -- the allocation, test criteria and planning for sustaining R&M -- are critical to quality. As the design continues product availability such as dimensions of mechanical structures or electrical component tolerance become a major quality consideration. Other key design quality features include designing for production (i.e., producibility) and design-to-cost (producing at a specified unit cost). Special and unique industrial design techniques are available to address these technical factors.

6. System Engineering

The principle of using systems engineering methodology, an iterative technical process, to transform the operational or user need into a technical product description, to integrate all program technical factors, and to specify the total engineering effort. Technical documentation, configuration management and technical reviews and audits are all part of systems engineering.

o Rationale. The systems engineering practices allows for the development of a complete set of system or product technical requirements, documented initially in a system specification. This document and lower-level documents emulating from it follow a structured corporate outline format to ensure completion and promote ease of understanding. In a complex program there may be as many as five types of specification, each with a specific purpose. At a point in the process systems engineering provides for configuration

management, the identification of the functional and physical characteristics of an item during its life cycle. As configuration management expands it accounts for and controls changes to those characteristics and maintains records and reports for re-procurement of subsystems, components and parts. Systems engineering provides a formal process of technical reviews and audits. These range from early and continuing design reviews, intermediate functional and configuration audits and subsequently a production readiness review which serves as the base for a corporate production commitment. The basic plan governing the system engineering effort is the System Engineering Management Plan (SEMP).

7. Affordability and Supportability

The principle of systematically planning and controlling technical factors of ownership in terms of affordability and supportability (and in commercial terms, competitiveness). Affordability is the determination that the program life cycle cost (assuming system or product effectiveness) is in consonance with corporate long-range investment and product plans. Supportability is stated in the form of logistics support parameters, wherein reliability and maintainability become the surrogates for supportability throughout the development, test, and production (life cycle) phases.

o Rationale. The manufacturing (production) and logistics support phase of acquisition program management are treated as part of the life cycle management principle in this document. Both functions are included as major elements of the systems engineering process. Manufacturing and/or logistics functions may not be a major part of another product life cycle (e.g., a one of a kind space system or a major software program). Affordability can act as a less complex surrogate for manufacturing as can supportability for logistics. Both are key cost drivers for the program. Affordability and supportability involve considerations and decisions at the decision-maker, project manager and contractor levels (albeit somewhat different). Both can highlight performance (e.g., kill effectiveness per dollar), are amenable to mathematical formulation, and can be measured. As concepts, both are easy to remember (but somewhat more difficult to assimilate). Both can be considered element of commercial competition. They address two basic questions: can the customer afford my product as compared to my competitors, and can it be operated and maintained effectively (supported) over its usage period?

8. Structured Test and Evaluation

The principal of structured program life cycle test and evaluation provides the major method of program risk management. Costly product re-design or modification can be reduced if properly planned. As a risk identification and reduction tool, test and evaluation (T&E) provides information to decision-makers responsible for deciding on the most effective use of resources.

o Rationale. Risk management is the means by which the program areas of product performance and uncertainty are identified and managed. T&E is the discipline that helps illuminate these areas of vulnerability. While the terms "test" and "evaluation" are most often found together, they actually denote clearly distinguishable functions. "Tests" denote the actual test of hardware/software -- models, prototypes, production equipment, computer programs to obtain technical data, etc. "Evaluation" denotes the review and analysis of

qualitative and quantitative data obtained from design reviews, hardware inspection and testing and operational usage of equipment. Today, T&E has reached a stage of importance in meeting pre-specified objectives requiring separate, detailed test and evaluation life cycle plans. Within the Federal Government, the Congressional requirement for T&E reporting from the DoD, and DoD's establishment of independent T&E organizations within its components, reflect decision-makers interest in assessment and management of systems utility and effectiveness. While the structured life cycle T&E program provides the major sources of formal risk management, aspects of risk management are inherent also in other program management functions (e.g., identification and analysis of programmatic risks by budget analysts).

9. Program Control

The principle of program control involves the use of management techniques and information for planning and controlling program schedules, cost and technical performance (and related risks). Program control includes cost estimating, milestone and master plan scheduling, PERT/CPM, and cost and schedule control techniques (and related technical status).

o Rationale. Program managers are responsible for technical management, business management and program advocacy. Program control is the major business management function and centers on the cost and schedule control procedure. Other business management functions include financing, contracting, administration, and data management. Most of the latter functions are corporate tasks with internal input and assistance from the program office. Complexity and uncertainty in most major programs can lead to continually increasing product costs, a key concern for program management. Program managers must have an effective internal cost and schedule management control (i.e., program control) system for all aspects of work. In many cases, program control must rely on timely and auditable input data from its contractor systems. A formal program control procedure includes use of program work breakdown structures; the concept of work packages at the lowest level of management; work measurement, earned value and estimate-to-complete techniques; a relationship to technical status and technical performance measurement; and, an integrated audit and reporting system. Control of schedules, cost and technical performance is one, if not the most, critical tasks of program managers.

10. Continuous Management Improvement

This principle reflects the need for program managers, collectively and individually, to be informed about, to promote and to use new automation technology to improve the effectiveness and efficiency of program management and the physical processes used for developing, producing and distributing/deploying the system and products they are managing. Computed Aided Design (CAD), Computer Aided Manufacturing (CAM) and Computer Acquisition Logistics Systems (CALS) are three of the major new automation initiatives being developed and used in program management.

o Rationale. Management in general has undergone a revolution in its content and the application of new management techniques. Computer, communication and information technology is affecting industrial organizations,

processes and methods as digital automation applications evolve. No where is this more evident and critical then in major program management activities. Both physical engineering and business/technical information process improvements are critical to improving productivity and reducing program complexity and costs. Program management is expecting to enter an age of near-paperless processes over time. Computer-aided design (and manufacturing) will provide technical documents and configuration data in digital form. Computer-integrated manufacturing technology will provide for automated factories. In turn, the computer acquisition logistic system will improve almost all aspects of follow-on material management. Program managers leadership in understanding, applying and nurturing these developments can be critical to progress and have a composite impact on U.S. competitiveness.

SUMMARY

The writer states that the program management discipline as defined by DSMC documentation is based on a composite of related functional disciplines and supporting management practices. He hypothesizes that a set of program management principles can be developed from the DSMC body of knowledge that would simplify the basic structure and clarify the understanding of the program management fundamentals. In his research and analysis he postulates a set of ten principles and the rationale for the selection of each. He draws no conclusions.

The writer hypothesizes several possible values in using a set of management principles to link the program management body of knowledge and its supporting structure. If a set of management principles can be defined and agreed on, they may provide a clearer line of demarkation between program management and other management disciplines and functional entities. Having narrowed the art of program management to a limited set of descriptors, it would seem program management could claim and justify a high degree of uniqueness. As each program management principle is extended to successive lower levels of detail, less overlap with other functions should occur. Finally, education and training learning objectives under this approach could probably be stated more clearly and more easily measured during performance.

It is recommended that DSMC, NCMA and other interested parties employ a volunteer group of program management experts to investigate the propositions and hypotheses as set forth herein.

ACTIVITY BASED COST ACCOUNTING

Norman E. Bielmeier
Chief, Contract Operations Branch
DCMO Buffalo
DCMAO Syracuse
DCMD Northeast

ABSTRACT

With the advent of Computer Integrated Management (CIM) Systems, Robotics and flexible manufacturing lines, less direct factory labor is necessary. Many Defense Contractors have automated their factories; others are in the process of automation and there are those still investigating the various possibilities.

It has become evident to most, however, that the use of traditional cost accounting systems in a highly automated environment can lead to cost distortion when a traditional labor base system is used to accumulate costs.

This article explains Activity Based Costing (ABC), where it came from and, what it can do for American Business. Further, it gives some examples of how ABC can help true product costing and aid management in making intelligent business decisions. Finally, it will show the relevance of Activity Based Cost Accounting to Defense Contracting.

ARTICLE

Activity Based Costing (ABC) is an accounting procedure that recognizes activities and processes as a more relevant basis for the spreading of overhead than a direct labor base system. The ABC system causes the activities that use overhead to be charged with the proper amount of overhead. Kevin Kelly, a staff writer for Business Week, tells us that the reason the Direct Labor Base (DLB) is no longer a good basis for allocation of overhead is that direct labor is now only 15% of total cost in most industries. In some hi-tech industries it may be as low as 5% (43). Norm Raffish, one of the Senior Managers at Ernst and Young, states that 5% to 15% is in the ballpark (36). Some of the examples in Exhibit A show that one of the local companies average 2%-3% and in one case with setups removed, direct labor is only 1.3% of total cost. Theoretically, in a company utilizing a Computer Integrated Manufacturing (CIM) system, the time for setups should be close to zero since after the machines are programmed the first time, there should be virtually no set up time.

In automated factory environments that have 15% or less of direct labor to total cost, a DLB is inappropriate as means of spreading overhead; Overhead may be as high as 50% of total product cost. Exhibit B shows how a direct labor based system arrives at a total cost of $668.33 for a widget and $1181.66 for a gadget. The total amount of overhead to be spread is $770.00. The overhead is then divided by the total direct labor dollars ($240.00) and that

factor is multiplied by the individual direct labor dollars for widgets and gadgets.

In Exhibit C, a Processing Time Based system is used. Processing time could be machine hours. It may be easier to think of machine hours as a cost driver in a factory that has only a 2%-3% direct labor base. In this example, the total overhead is still $770.00; however, this overhead is spread by the available 12 processing hours. Dividing the $770.00 by those 12 hours yields a factor of 64.166. This factor is then multiplied by the processing dollars for widgets and gadgets. You should note that, under the processing time basis, the cost allocation is exactly the opposite of the direct labor base; the total cost of the widget or gadget is either $668.33 or $1181.66 depending upon the base used. Further note that the numbers used in Kevin Kelly's article in Business Week are incorrect. Kelly spreads the $240 dollars of processing cost that are already included in the product cost (43). (Please see Exhibits B and C for an example)

The ramifications of different overhead bases are very easy to deduce. Using a Direct Labor Base to spread overhead in a highly automated factory will spread the overhead incorrectly. This means that product pricing will have no direct correlation to the resources used, nor will the price reflect the real cost. Some products will be undercosted and some will be overcosted. Clearly, if this cost data is used for management decisions, wrong decisions could be made. If management bases their decision on this cost data to shut down a product line or a plant, they will make a serious mistake with far reaching effects.

Where did ABC come from? Gerald Aiyathurai, of Peat Marwick, states that "Activity Accounting" was first developed and introduced by Eric Kohler in the 1930s (61), while he was working for the Tennessee Valley Authority. The concept, devised 50 years earlier, was not used until the 1980s. Don Bohl states that it was Dr. Robert S. Kaplan, of Harvard University, who first sounded the alarm in the Harvard Business Review in August of 1984 (1). Kaplan argued that "cost distortions produced by the archaic accounting system were hobbling American competitiveness" (Bohl 1). The next major breakthrough came in 1986 when Computer-Aided Manufacturing International (CAM-I) was formed. CAM-I was initiated as an association of 40 major manufacturing and accounting firms. This group came up with a conceptual frame work and better accounting systems.

Around that same time, Peat Marwick came up with an ABC service that relied on software developed by Robert Kaplan and Robin Cooper of Harvard (Bohl 2). This service finds the real cost drivers and then implements the use of that driver to show the true cost of goods manufactured.

What can Activity Based Costing do for business? ABC is the only one of the methods called Advanced Cost Management Systems (ACMS) by the Defense Contract Audit Agency (DCAA). These systems point out direct relationships between cost accumulation and the driver that causes the cost to occur. The essence of ABC is that a simplistic direct causal relationship exists between the cost driver and the items being produced. James A.

Henricks notes that different rates should be used for different department or different manufacturing cells if the level of automation differs, or there is a difference in activities or cost drivers (5).

ABC can show management how their resources are being used. Once direct labor is replaced, as the base, with machine hours; a new relationship between the resource (the Machine) and the products is clearly seen. If the machine is run on electricity, it is obvious that the monthly utility bill is not a fixed cost at all. If the machine must be financed, one can now draw an exact relationship between the monthly finance cost of the machine and the return on the investment. In other words, ABC offers a host of new, vital information to assist management in making intelligent, worthwhile business decisions.

Beyond that, from an accounting theory perspective, true product pricing is achieved through the use of ABC. If a company is to become more competitive, it must know what it's products really cost. Robin cooper, of Harvard University, states that "Managers in companies selling multiple products are making important decisions about pricing, product mix, and process technology based on distorted cost information" Cooper, 1990 (38). Haedicke, of Hughes Aircraft, states that the direct labor based system had its origin at General Motors during the era of Sloan and DuPont (30). Recent decisions by General Motors to sell and close plants were likely made based on distorted accounting data. General Motors is doing poorly and it is not without merit to question their accounting system-an overhaul of that system could have made a difference in which plants General Motors decided to close.

How is all of this relevant to Defense contracting in the future?

Most of our defense contractors use a direct labor base for product costing. As contractors continue to automate, their direct labor input base will drop. If our contractors start using Computer Integrated Manufacturing, their setup labor will be drastically reduced, if not all but eliminated. The result of this drop of direct labor input cost to less than 15% of total product cost will be a distortion of overhead cost allocation.

What does this do to the defense industry? Cost data will certainly be distorted. Some products will be underpriced while others will be overpriced. Defense managers, when making strategic decisions based on distorted cost information will, in most cases, make the wrong decisions. Specialized defense products taking a large portion of a company's resources are very likely neither fair nor reasonably priced. In the interest of fair and reasonable prices, defense contractors that highly automate should investigate and evaluate ABC costing. Defense contractors who have highly automated production facilities could be under costing their specialized military product lines and over costing their non-complex commercial product lines.

DIRECT LABOR ANALYSIS

CATEGORY	HOURS/ UNIT	UNIT/ EFFCY	EXTENDED COST	
MFG	HRS	$	$	
SETUP	22.960	0.34	596.51	
MACHINE SHOP	0.054	0.33	578.75	
ASSEMBLY & TEST	0.001	0.01	22.90	*23.331 Total*
PLATE	0.022	0.23	412.49	*-22.960 Setup*
PAINT	0.000	0.00	0.00	*.371*
PACKAGING	0.052	0.68	1203.59	
RUBBER MOLD	0.002	0.03	53.21	
INSPECTION	0.022	0.39	685.70	*23.331*
OTHER	0.217	2.41	4286.18	*1.5%*
TOTAL MFG LABOR	23.331	4.42	7839.33	
OVERHEAD ●	357.9%	15.81	28056.98	
MFG	HRS	$	$	
SETUP	0.300	0.01	23.97	
ASSEMBLY	0.501	3.71	6589.05	
INSPECTION	0.007	0.10	182.16	
TOTAL MFG LABOR	0.808	3.83	6795.18	
OVERHEAD ●	400.4%	15.33	27207.91	
MFG	HRS	$	$	
SETUP	0.000	0.00	0.00	
ASSEMBLY	0.077	0.60	1067.57	
INSPECTION	0.000	0.00	0.00	
TOTAL MFG LABOR	0.077	0.60	1067.57	
OVERHEAD ●	268.9%	1.62	2870.70	
TOTAL MFG:		$	$	
TOTAL MFG LABOR:		8.85	15702.09	
OVERHEAD		32.75	58135.59	

EXHIBIT A

COST BREAKDOWNS

PART NUMBER	OT2146	F282-1120-4	OT2160	OT2128
Material	569.03	431.83	5857.88	1530.40
Labor	16.28	12.53	47.06	22.66
Mfg. Overhead	44.64	34.36	129.04	73.10
Manufacturing Cost	629.95	478.72	6033.98	1630.16
G & A	138.59	105.32	1327.48	358.64
Total Cost	768.54	584.04	7361.46	1988.80
Fee	153.71	116.81	1472.29	397.76
Cost of Money	1.70	1.30	9.21	3.39
Unit Price	923.95	702.15	8842.96	2389.95
DL/TC	2.1%	2.14%	0.63%	1.34%

$$\frac{16.28}{768.54}$$

=.021183

OR 2.1%

EXHIBIT A

TOTAL COST
DIRECT LABOR BASE

WIDGETS	GADGETS
DIRECT LABOR DOLLARS	
$40	$200
PRODUCTION COSTS	
$540	$540
OVERHEAD	
$168	$842
$708	$1382

1010/240=4.20833

N. BIELMEIER

EXHIBIT B

ACTIVITY BASED COSTING
PRODUCTION COSTS

WIDGETS	GADGETS
LABOR @ $10 / HOUR	
$40	$200
MATERIALS AND PARTS	
$300	$300
PROCESSING @ $20 / HOUR	
$200	$40
------------	------------
$540	$540

N. BIELMEIER

EXHIBIT B

TOTAL COST
PROCESSING TIME BASE

WIDGETS	GADGETS
PROCESSING DOLLARS	
$200	$40
PROCESSING TIME	
10 HRS	2 HRS
PRODUCTION COSTS	
$540	$540
OVERHEAD	
$842	$168
$1382	$708

1010/12 HRS = 84.2

N. BIELMEIER

EXHIBIT C

Works Cited

Aiyathurai, Gerald, W.W. Cooper, and K.K. Sinha. "Note on Activity Accounting." Accounting Horizons, Dec. 1991: 60-68.

Bohl, Don L. "Activity-Based Costing: Growing Quietly." Finance Forum, Apr. 1990: 1-3.

Cooper, Robin and Robert S. Kaplan. "Activity-Based Systems: Measuring the Costs of Resource Usage." Accounting Horizons, Sept. 1992: 1-13.

Cooper, Robin and Robert S. Kaplan. "Measure Costs Right: Make the Right Decision." The CPA Journal, Feb. 1990: 38-45.

Haedicke, Jack and David Feil. "Hughes Aircraft Sets the Standard for ABC." Management Accounting, Feb. 1991: 29-33.

Hendricks, James A. "Accounting for Automation." Mechanical Engineering, Feb. 1989: 64-69.

Kelly, Kevin. "A Bean-Counter's Best Friend." Business Week/Quality, 1991: 42-43.

Lee, John Y. "Activity-Based Costing at CAL Electronic Circuits." Management Accounting, Oct. 1990: 36-38.

Raffish, Norm. "How Much Does that Product Really Cost?" Management Accounting, Mar. 1991: 36-39.

Steimer, Thomas E. "Activity-Based Accounting for Total Quality." Management Accounting, Oct. 1990: 39-42.

A NEW BEGINNING: ACQUISITION PLANNING WITH SOFTWARE REUSE

Robert J. Bowes, Theresa R. Huber, DSD Laboratories, Inc.

ABSTRACT

Integrating software reuse principles into systems acquisition practices and software engineering processes provides a basis for dramatic improvement in the way software-intensive systems are developed and maintained over their life cycle[1]. The DoD is currently developing plans to incorporate software reuse into all classes of software-intensive systems.

The DoD plans to require business managers (Program Executive Officers (PEOs)) to manage reuse across their systems[1]. This paper discusses how reuse can be practiced under the current acquisition structure and proposes a new structure, which follows from the DoD's central management theme, which will allow software reuse to be incorporated more effectively and efficiently. The concepts discussed here were developed under the Central Archive for Reusable Defense Software (CARDS) program, sponsored by ESC/AVS, Hanscom AFB, MA. These ideas are contained in two acquisition-related handbooks: Acquisition and Direction Level[2] Handbooks[3].

INTRODUCTION

Software reuse is a process in which software resources are employed in more than one system. Reuse can occur within a system (e.g., F-14A, B, ...), across similar systems (e.g., M1, Bradley, ...) or in widely different systems[1].

Application areas within which software components are reused are called domains. A domain is a group of related systems that share a set of common capabilities. These domains can be defined as vertical or horizontal domains. A vertical domain is a specific class of system, such as information systems, command and control or weapon systems. A horizontal domain consists of general software functions that are applicable across vertical domains[1]. Figure 1, Vertical and Horizontal Domains, illustrates the relationship between vertical and horizontal domains[4].

The DoD is planning to take software reuse one step further to reach systematic reuse, where opportunities are pre-defined and a process for applying those opportunities is fully specified[1]. To reach systematic reuse and the long-term benefits of shorter schedules, decreased costs and higher quality and reliability, the DoD has developed a Software Reuse Vision and Strategy. The services are currently developing compatible supporting reuse strategies and planning documents.

The DoD Software Reuse Vision and Strategy document focusses on incorporating software reuse into all classes of software-intensive systems: information systems, command and control systems, and weapon systems. The plan includes an analysis of the business, technical, and development context in which to implement a software reuse strategy, so that the DoD can move towards a process-driven, domain-specific, reuse-based, technology-supported model for software-intensive development. To support software reuse, the DoD will invest in an infrastructure that centers on advancing technologies that

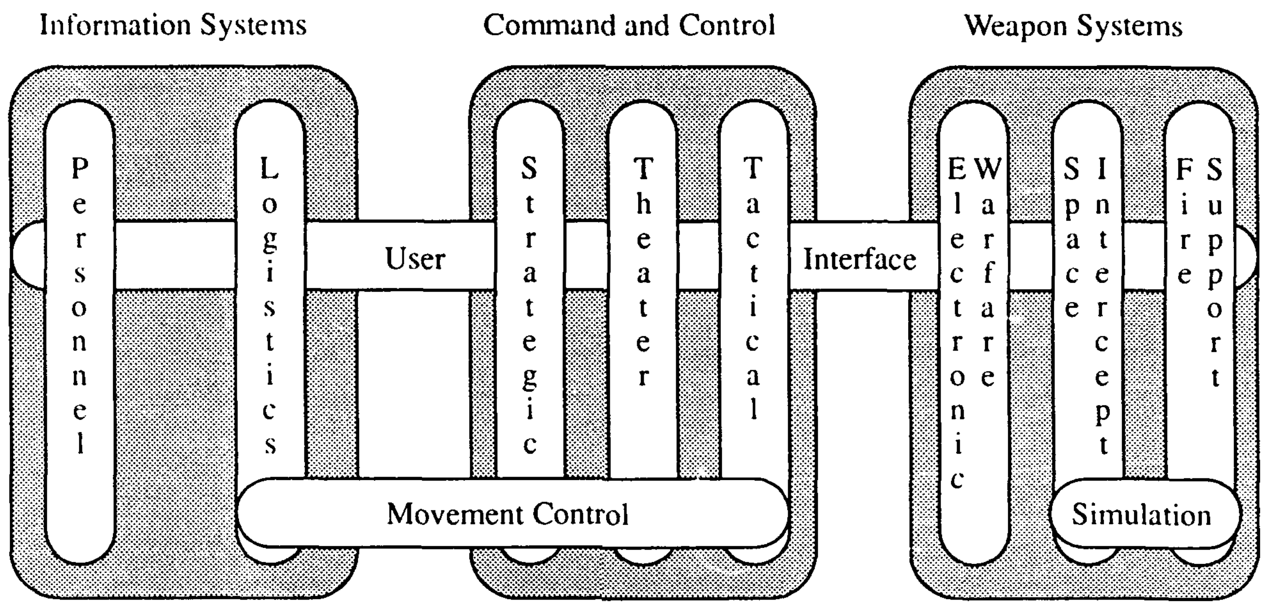


Figure 1
Vertical and Horizontal Domains

support reuse, incorporating reuse into management and engineering processes, and creating generic sets of components to reuse in new systems and in software maintenance.

The DoD's vision includes requiring business managers to establish plans to manage reuse across their systems[1]. We recommend that a "Domain Management Office" be established to manage the domain. The Domain Management Office would perform the domain analysis and maintain the knowledge and associated requirements for a particular domain, as well as work together with Using Organizations and the Program Offices within the domain. This concept as well as roles and responsibilities of executives in this proposed structure is discussed in the following paragraphs as a "New Beginning" to future acquisitions.

A NEW BEGINNING

Integrating software reuse principles into systems acquisition practices and software engineering processes provides a basis for dramatic improvement in the way software-intensive systems are developed and maintained over their life cycle[1].

Implementation of software reuse at the beginning of the life cycle has demonstrated a number of benefits. The quality and reliability of software-intensive systems can be improved by using already proven software components or through prototyping. Existing components can be used to prototype a system/user's requirements; thereby, technical risks can be identified early and managed properly in order to reduce negative implications. System interoperability can also be enhanced through reuse. For example, systems will be able to interoperate more effectively with other systems by using a single communications package[5]. Reusing pre-tested software components can accelerate system development and deployment by reducing time spent in development, testing, and maintenance,

resulting in improved productivity. As a result, software acquisition costs (development and overall life cycle) are reduced significantly. New requirements and changing technologies can therefore be integrated on a continuing basis.

For reuse to be effective and achieve its broadest influence, Government executives must consider it in the earliest stages of the Acquisition Life Cycle. In the context of DoD Directive 5000.1, we are talking about reuse consideration at Milestone 0 and at every subsequent milestone throughout production and onto subsequent Post-Deployment Software Support (PDSS). This is critical, since studies today suggest that support costs can reach as much as 70-80% of overall life cycle software costs. To the extent that Government executives can avoid software development, improve its reliability and create multiple reuse environments across (and within) programs, the Government will achieve savings in time and dollars. These savings would be seen primarily in systems deployment and maintenance. In addition, operational effectiveness would be increased because of improved reliability, standardization and training.

Conceptually, Figure 2, Applying Reuse to the Current Acquisition Structure, describes how key players relate in the acquisition structure which exists today. It also shows how reuse could be best recognized by participants as a potential solution, and how it could be integrated into the acquisition and business strategy process. Those items shown in italics are not presently formalized for reuse in the current acquisition structure. What is most characteristic about this structure is its "ad hoc" nature. Until recently, there has been no systematic attempt to identify and integrate reuse as a sound systems/software engineering solution in the requirements validation and analysis process. As a result, central planning, programming and budgeting for reuse has been non-existent. A PEO-level program may embrace reuse (as is the case in the Army's Tactical Command and Control System (ATCCS) and its five nodal segments) Success Stories), but this has typically happened because of the drive of individuals, not policy. More often than not, when reuse is considered, it is at the single program level by an individual program manager. DoD's new Software Reuse Vision and Strategy document will begin to change this policy toward one that integrates advocacy at high levels with a proactive approach toward reuse. But, for now, reuse will only be effective if senior Government executives appreciate the importance of reuse, recognize its benefits, and foster its use.

Figure 2 today requires initiative by a PEO or Designated Acquisition Commander (DAC) or Program Manager to assess the viability of reuse as a technical solution to user requirements. It is best accomplished at the PEO/DAC level, and later validated through analysis and implementation by the Program Manager, since a PEO/DAC is likely to have a broader perspective in assessing program impacts (technical/schedule/cost) of reuse implementation than an individual Program Manager. In other words, the PEO/DAC is in the best position to control planned reuse across programs. This executive-level assessment of reuse viability has the advantages of: 1) enabling more objective assessment of reuse investment value on a single program versus potential savings in multiple programs; 2) considering applications within and outside the PEO/DAC's sphere of responsibility; and, 3) assessing the overall effectiveness of an implemented reuse strategy.

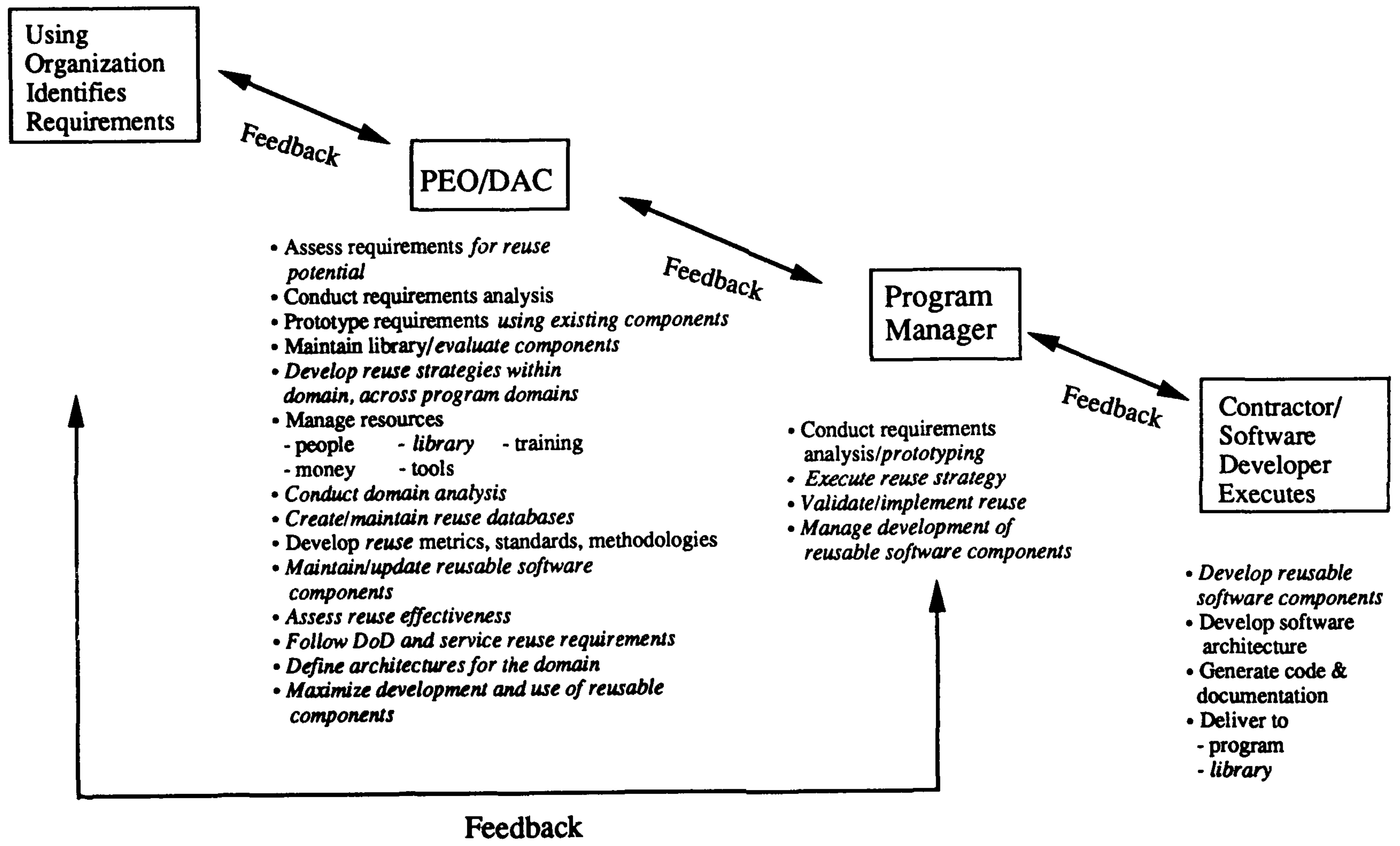


Figure 2
Applying Reuse to the Current Acquisition Structure

The shortcomings in reuse institutionalization today can be directly traced to an unorganized approach to its implementation. The lack of organization results from the ambiguity in responsibility for reusable components. To the extent that reuse is practiced today, applications are program specific. The Government Program Manager initiates reuse, the program is completed, the reusable component is delivered to a user, and (with luck) a library. The component is never updated (or at least not regularly). No one is assessing its viability for similar domain applications, unless a specific program becomes aware of the component. The result - probably a one time or two time application, then the component is forgotten/abandoned.

Some applications transcend the majority. The Army ATCCS program has focused on component reuse in its nodes. The Navy AX Weapon System program is requiring examination of Air Force ATF components for reuse potential. These are significant steps within and across program domains. Unfortunately, there is no clear indication that anything will follow beyond these applications, since no comprehensive plan to institute reuse has been implemented.

The introduction and institutionalization of the Domain Management Office - an organization charged with development, improvement, ownership and application of reusable components within and across programs is proposed. The previous model is repeated here, adding the concept of domain management.

The Reuse Acquisition Planning Structure, Figure 3, describes an environment where an organization interfaces with Using Organizations, PEOs/DACs, Program Offices and industry to:

- Identify needs
- Perform domain analysis to support systems engineering and requirements analysis
- Develop/identify/maintain/research/upgrade components for reuse application within the domain
- Improve reuse through development of metrics, standards, methodologies, training and tools which are further refined through feedback
- Assess the effectiveness of reuse
- Populate and support a domain-specific library for components
- Propose, develop and manage a budget to support reuse resources
- Identify steps to resolve legal ownership issues to balance industry and Government needs

The domain management function would centrally manage software reuse for a particular domain. Software reuse strategies would be developed and implemented at this level.

The Domain Management Office would maintain the domain knowledge and associated components. To successfully incorporate reuse into systems acquisition, this office would conduct and refine domain analyses, develop and maintain the domain model, and manage resources (library, personnel, funding allocations, software tools).

According to the DoD Software Reuse Vision and Strategy, software development will become both domain-specific and library-based. These libraries would not only be tailored to the domain at hand, but be driven and built around the domain model and software architecture. The domain-specific library would focus not just on components, but also on the relationships

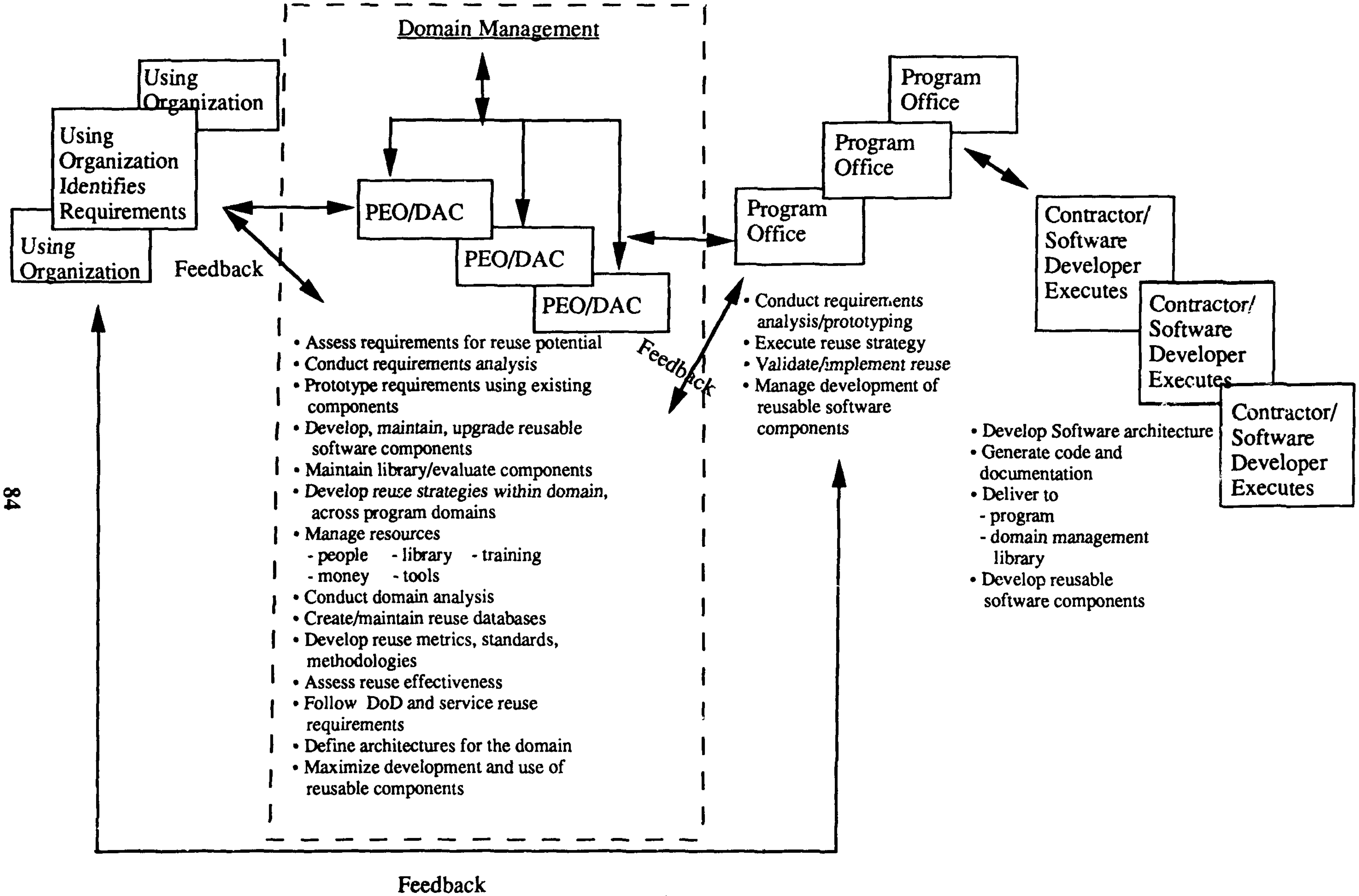


Figure 3
The Reuse Acquisition Planning Structure

that exist between these components[6]. The components include all levels: domain model, software architecture, product design, and implementation components, as well as requirements and other conceptual models to support prototyping. In addition to these components, the library would contain reuse metrics to evaluate technical, schedule, and cost considerations for assessing reuse effectiveness. To maintain the domain model and the software architecture, the Domain Management Office would interact with both the Using Organization and the Program Office (See Figure 3, Reuse Acquisition Planning Structure).

The Domain Management Office and the Using Organization together develop high-level requirements to fulfill the users needs/system. Cost, benefit and risk trade-offs are made by prototyping the requirements using existing high-level components (domain model and software architecture) from the supporting library. Output from this high-level requirements analysis is incorporated into the domain model. This allows the requirements to be managed at the domain level in addition to the system level as they are now. In turn, requirements from each system developed would be mapped into the domain to which the system belongs. With reusable components managed at the domain level, the components can be mapped centrally to various systems in the domain[4].

The Domain Management Office and the Program Office together would refine the system's requirements through additional prototyping, using low-level (designs and implementation components) components. Output from this system requirements analysis would be incorporated into the software architecture for the particular domain. Reusable components managed at the domain level would be mapped to the various systems via the domain-specific library[4]. Thus, the software architecture is maintained by the Domain Management Office with support from the Program Office.

Prototyping systems by using existing components would be accomplished at two levels. User requirements can be prototyped initially at the domain model/software architecture level. The user and system requirements can be further refined by prototyping using implementation components. This process allows not only quicker validation of requirements and a timely determination of feasibility, but can provide early detection of errors and benefit other systems being developed within the domain.

The Domain Management Office would accumulate technical, schedule and cost reuse metrics collected by the Program Offices, and make them available to developers and other acquisition managers of systems within the domain. The technical, schedule, and cost baselines for a new system could be determined by using actual statistics from programs within the same domain. Acquisition and Reuse Plans as well as cost estimates would be more accurate.

The domain management function is a somewhat revolutionary concept. The current acquisition organizations may be threatened by perceived: (1) loss of control/authority/autonomy; (2) increased risk (technical/cost/schedule) caused by dependence on "someone else's products"; and (3) reductions in program budgets due to the requirements for increased support for reuse at the domain management level.

In actuality, this change is inevitable and

already occurring. DoD budgets are shrinking. DoD-level organizations have been created to eliminate development duplication among the services and consolidate common functions. Perhaps what remains is the decision regarding whether acquisition executives (PEOs/DACs) are reorganized to be "dual-hatted" for program and specific lead domain function responsibilities, or that PEOs/DACs co-exist with the Domain Management Offices. It is suggested that PEOs/DACs retain lead responsibilities and that the domain management function is matrixed to their PEO/DAC organizations.

Figure 4, A Comparison of Reuse Roles and Responsibilities, provides a summary of how reuse might be impacted by the concept of the domain management function. It portrays where shifts in responsibilities would occur when moving from the current acquisition structure to the reuse acquisition planning structure. The chart depicts how we see significant reuse activities managed under the current acquisition structure and how we expect they would be managed under our proposed structure. The "ad hoc" approach is replaced by an organized structure which assures a repeatable and effective process.

RESPONSIBILITY

Activity	Reuse Applied to the Current Acquisition Structure	Domain Management Acquisition Structure
(1) Domain analysis	(1) PEO/DAC	(1) Domain Management Office
(2) Reuse budget	(2) PEO/DAC	(2) Domain Management Office
(3) Cost estimate - For reuse - For program	(3) - PEO/DAC - PEO/DAC	(3) - Domain Management Office - PEO/DAC
(4) Risk assessment - For reuse - For program	(4) - PEO/DAC - PEO/DAC	(4) - Domain Management Office - PEO/DAC
(5) Program strategy - Overall - Reuse - Library	(5) - PEO/DAC - PEO/DAC	(5) - PEO/DAC - Domain Management Office
(6) Reuse component management - Upgrades - Maintenance	(6) Ad Hoc	(6) Domain Management Office
(7) Training, tools, policies	(7) Ad Hoc	(7) Domain Management Office
(8) Data base creation, maintenance, improvement	(8) Ad Hoc	(8) Domain Management Office

Figure 4
A Comparison of Reuse Roles and Responsibilities

APPLICATIONS

Under this reuse acquisition planning structure, the proposed Domain Management Office, Program Executive Officer and the Program Manager can utilize tools and templates from the CARDS Acquisition and Direction Level Handbooks to incorporate software reuse into their respective duties. Software reuse guidance is presented by providing methods, examples, recommendations and techniques to implement various reuse strategies throughout the acquisition life cycle. The implications and affects of software reuse on the technical, management, cost, schedule, and risk aspects of a program/system during the acquisition process is the foundation of both documents. The domain manager can use this guidance to develop plans to manage reuse across their systems and to reach the goals outlined in the DoD Software Reuse Vision and Strategy document. The Program Executive Officer can use the information to assist in incorporating software reuse into the initial planning stages of an acquisition, as well as at critical points within the acquisition life cycle. The options allow the executive to gain the greatest benefits from software reuse while optimizing the use of shrinking resources. Program Managers and their support personnel (such as Contracting Officers and Administrators, procurement attorneys, and program control personnel) can utilize the guidance to incorporate software reuse into all phases of the acquisition life cycle, from concept exploration to Post Deployment Software Support (PDSS) and from planning the acquisition strategy through awarding the contract to managing the effort and follow-on support.

Some examples of these tools are: Figure 5, Reuse Acquisition Process Steps; Figure 6, Reuse Considerations; and Figure 7, Common Functionalities Across Program.

Figure 5, Reuse Acquisition Process Steps, takes the executive through the typical steps in the acquisition process and identifies specific reuse activities which should be accomplished in each step. The parenthetical references are to the sections within the Acquisition Handbook where each topic is discussed extensively. As an example, columns 2, "Initiate Program Direction and Acquisition Planning" identifies activities the executive should assure are either addressed and resolved prior to moving to the next step or, at least, are provided a milestone for completion in the future.

Figure 6, Reuse Considerations, provides specific issues that must be considered by the executive. For instance, column 3, "Initial Investment', shows what must be considered when first applying reuse concepts. These items are not all inclusive and will be expanded and improved upon as more experience is gained.

Common Functionalities Across Programs, Figure 7, provides a methodology for assessing commonality of functions across programs within a particular functional area. It can also be used across agencies, for example, to identify common avionics functionalities among all military services. This perspective enables the executive to not only assess whether reuse may be practical but also, with supporting data, to identify whether a lead program, or programs , can be identified for various functions. It also facilitates development of inputs for cost effectiveness assessments by categorizing the degree of expected commonality and potential cost avoidance. This particular example addresses intelligence training systems.

Identify Requirement (User Need)	Initiate Program Direction & Acquisition Planning	Create Solicitation to Reflect Direction and Planning	Evaluation and Selection of Contractors	Program Execution (Design Reviews, Integration & Test, and Development Activity)	Operation and Maintenance
• Initiate domain analysis to assess (2.4, 2.4.1) - Reusability - Reuse alternatives • Identify applicable domains (2.4, 2.4.1) - Precedented - Unprecedented • Initiate cost estimate & schedule activity for reuse (2.4.2, 2.4.3, 6.4) • Identify risks (2.4.4) • Develop/maintain/ improve reuse databases - Technical - Cost (2.4.3) - Metrics	• Initiate/continue dentification of applicable domains (2.4, 2.4.1) • Initiate/continue domain analysis to assess (2.4. 2.4.1) - Reuse viability - Reuse alternatives • Identify technical, business, schedule drivers for reuse - Use Reuse Considerations table (2.4) - Finalize acquisition planning (2.4) - Identify business issues (2.4, 2.5) - Copyright, etc (6.5, 6.9) • Refine cost estimates (2.4.3, 6.4) • Identify risks (2.4.4) • Determine contract type (2.4.5) • Identify reuse criteria (2.4.6, 6.1) • Define domain architecture approach (2.4.1,3.2) - Government specified or contractor solicited - Standards to be used (3.2) • Identify possible component sources (3.2) • Develop/maintain/ improve reuse databases - Technical - Cost (2.4.3) - Metrics	• Create reuse requirements documentation (3.1.2) • Finalize evaluation criteria (2.4.6, 6.1) - Technical - Cost - Management - Schedule • Finalize proposal instructions (3.1, 6.1) - Technical (3.1.2) - Management (3.1.1) - Cost (3.1.4) - Special Issues ∘Royalties (3.1.5) ∘Software Rights (3.1.6) • Identify data deliverables (3.1, 3.3, 3.3.2, 3.3.3) • Identify available Government information (3.2) - Documentation - Software components • Develop/maintain/ improve reuse databases - Technical - Cost (2.4.3) - Metrics	• Create and use evaluation standards (4.1, 6.3) • Analyze considerations and checklists for evaluation of technical and management issues (4.2, 4.3) • Cost evaluation techniques (4.4) • Develop/maintain/ improve reuse databases - Technical - Cost (2.4.3) - Metrics	• Use progress metrics in Design Reviews (5.1, 5.2, 5.3) - Technical (5.2) - Schedule (5.3) - Cost (5.3) - Management (5.1) • Assess reuse objectives compliance in test (5.1, 5.2, 5.3) • Provide data for metrics refinement (5.1, 5.2, 5.3) - Current program use - Future program Use • Develop/maintain/ improve reuse databases - Technical - Cost (2.4.3) - Metrics	• Assess reuse objectives compliance (5.1, 5.2, 5.3) • Provide data for metrics improvement (5.1, 5.2, 5.3) • Develop/maintain/ improve reuse databases - Technical - Cost (2.4.3) - Metrics

Figure 5
Reuse Acquisition Process Steps

Implementation Plan	Strategies	Initial Investment	Schedule	Cost	Risk	Management Support	Regulatory/ Managerial Considerations	Incentives	Liability	Documentation
●Maturity of domains - Precedented vs. unprecedented ●Commitment of resources to investigate reuse - Quality and experience of personnel ●Existing technology base ● Existing resource base ●Mandate domain analysis ●Availability of metrics ●Communication between User and PEO/DAC regarding domain model ●Communication between PEO/ DAC and Prog Mgr regarding architecture	●One time vs. multiple reuse ●Need for Government maintenance capability ●Level of rights ownership required ●Commercial product potential ●Industrial base maintenance/ expansion ●If Government ownership, who maintains	●Technology support for reuse initiatives -tools -methodologies -databases ●Domain analysis ●Domain mgr structure ●Libraries ●Training & education costs ●Technology transfer ●Library population	●Impact on program schedule -Library search -Developing for reuse -Documentation & test for reusable components -Parallel development	●Develop reusable components ●Use existing reusable components -"As Is" or modified ●Cost of incentives, royalties, license fees, award fees ●Library operation & maintenance	●Technical -Lack of libraries & tools -Ability to define reuse objectives -Maturity of reuse system engineering process -Inadequate documentation ●Schedule -People -Models ●Cost -Budget availability -Cost model availability ●Metrics availability ● Lack of understanding of reuse requirements ● Knowledge and experience level of personnel	●Commitment & advocacy ●Funding support ●Implementation authority ●Availability of metrics ●Communication between User and PEO/DAC regarding domain model ●Communication between PEO/ DAC and Prog Mgr regarding architecture ● Provision of adequate education and training	●Rights - Ownership levels - Copyright ●Recoupment ●Clear policies on reuse goals ●Adaptability of policies & regulations to support reuse objectives ●Availability of metrics to assess reuse goal progress ●Communication between User and PEO/DAC regarding domain model ●Communication between PEO/ DAC and Prog Mgr regarding architecture	●Government - Cost & schedule potential savings - Lower risk - Career motivation ●Contractor - Financial return on investment -Commercial product potential -Competitive advantage	●Need for warranty coverage - Performance - Quality ●Third party responsibility	●Reuse strategy plans ●Metrics reporting ●Reuse development plan ●Support for changes in methodologies & documentation ●Test & refine feedback ●Proposal data requirements - evaluation ● Adequacy of software/ system documentation

Figure 6
Reuse Considerations

FUNCTION	PROGRAMS			
	Current Program	Program #2	Program #3	Program #4
Message Handling	High Commonality	Good Commonality	High Commonality	High Commonality
Data Management	Good Commonality	Good Commonality	Good Commonality	Good Commonality
DBMS	Good Commonality	Good Commonality	Good Commonality	Good Commonality
Software Architecture	High Commonality	Good Commonality	Good Commonality	High Commonality
User Interface	High Commonality	Good Commonality	High Commonality	Some Commonality

Figure 7
Common Functionalities Across Programs

CONCLUSION

While developing the concepts described in this paper, we have worked with the organizations within DoD which are sponsoring and supporting reuse. The Management Issues Working Group (MIWG), which includes representatives from OSD, all the services, DISA, Defense Logistics Agency and the National Security Agency, has reviewed and commented on related work. Our approach has been to work with these groups and others to obtain the widest possible perspectives and ideas. We have also received support from industry in review and critique of our work. These organizations, along with the acquisition and software reuse communities, must work together to implement these concepts to reach the cost and schedule benefits of software reuse.

BIBLIOGRAPHY

1. DoD Software Reuse Vision and Strategy, Document # 1222-04-210/40, 15 Jul 92

2. Acquisition Handbook, Final, Central Archive for Reusable Defense Software (CARDS), STARS-AC-04105/001/00, 30 Oct 92

3. Direction Level Handbook, Final, Central Archive for Reusable Defense Software (CARDS), STARS-AC-04104/001/00, 20 Nov 92

4. The Army Strategic Software Reuse Plan, Final, 31 Aug 92

5. NATO Standard for Management of a Reusable Software Component Library, Volume 2, NATO Communications and Information Systems Agency

6. Technical Concept Document Update (draft), Central Archive for Reusable Defense Software (CARDS), STARS-AC-03536/001/00, 3 Aug 92

DOD'S NEW SENIOR ACQUISITION COURSE: A FIRST YEAR REPORT

by

Dr. Linda S. Brandt
Course Director, Senior Acquisition Course
and
Col. Francis W. A'Hearn (USAF-Ret.)
Deputy Chairman, Department of Resources Management

Industrial College of the Armed Forces

ABSTRACT

In 1992 - 1993, a ten-month Senior Acquisition Course was offered for the first time to a select group of senior military and civilian acquisition professionals. Growing out of legislation enacted by Congress which also created the Defense Acquisition University, the course is designed to provide senior acquisition professionals with an educational experience which is comparable and equivalent to that of a senior service school or war college. This paper provides an analysis of the first year's experience with that new course, conducted at the Industrial College of the Armed Forces. It examines the genesis of the course, needs asessment, course content, and preliminary results of the first year offering. In addition, the paper analyzes students selected for the course in terms of make-up, experience, and credentials. Finally, it briefly examines possible future directions for both the senior course and students likely to complete it in the evolving acquisition career workforce environment. It is expected that this analysis will provide important insights for policy makers, practitioners, and educators concerned with shaping needs for senior level acquisition education as well as for the intermediate education levels which precede it.

INTRODUCTION

On June 16, 1993, a group of 37 highly select senior military officers and civilian officials graduated from the first senior acquisition course with full status comparable to that of any senior service college in the Department of Defense. This new Senior Acquisition Course, conducted at the Industrial College of the Armed Forces (ICAF), marks the first offering of its kind to senior professionals in the critical business of defense acquisition management. Borne out of legislation which also created the Defense Acquisition University, the course represents a turning point in providing an executive-level educational program for those select acquisition leaders and managers who may be destined to rise to general and flag officer or senior executive service positions in the acquisition workforce.

The genesis of this new course, along with an analysis of the work that went into student needs asessment, curriculum design, and the first year's experience in conducting it, provide important insights for policymakers, practitioners, and educators concerned with shaping future directions in executive level acquisition programs.

BACKGROUND

Through the latter half of the 1980s, a series of comprehensive studies were conducted at the Defense Systems Management College aimed at enhancing the professional acquisition career field. Impelled in part by those studies, Congress enacted legislation (10 USC 1746) in 1990 which established a new Defense Acquisition University (DAU) to oversee the educational needs and programs of professionals in that workforce. In addition, the law directed DOD to establish "a senior course as a substitute for, and equivalent to, exisiting senior professional military education (PME) school courses, specifically designed for personnel serving in critical acquisition positions."

Responding to this requirement, the Under Secretary of Defense (Acquisition) [USD(A)] on July 1, 1991, announced his choice of the Industrial College of the Armed Forces, which currently met all statutory requirements for senior PME, to take on this enhanced educational mission for senior members of the DOD acquisition workforce. The Chairman, Joint Chiefs of Staff, under whose auspices ICAF falls, joined in agreeing to USD(A)'s oversight of the acquisition content of the ICAF curriculum.

Interestingly, this new task built upon an historic part of the ICAF mission which had its roots in the College's original 1924 charter as the Army Industrial College. (re-established as the present day Industrial College in 1948) War Department General Order No. 7, 1924, established the purpose of the institution to include educating officers in the "supervision of procurement" of military equipment. Nearly 70 years later, the contemporary ICAF mission similarly calls for providing a senior education with "special emphasis on materiel acquisition."

Thus chartered by the USD(A), ICAF began the process of designing and developing the new Senior Acquisition Course to be offered in Academic Year 1992 - 1993.

NEEDS ASSESSMENT

The standards for all senior PME courses are established by the Military Education Policy Document (MEPD) CM 344-90, issued by the Chairman of the Joint Chiefs of Staff. In general, senior PME is 10 months in duration and is to consist of common core requirements focused at the national strategic level, incorporating both national and international considerations as they affect the formulation of national security policy. Each college is expected to augment studies in national security

with studies associated with its unique mission. In the case of ICAF and the Senior Acquisition Course, this translates into an emphasis on the *resources* which support national strategy including the means whereby we *acquire* them and the responsiveness of the national and global industrial base which provides those resources.

Building upon that basic foundation, a team was assembled to systematically assess the special educational needs of senior acquisition professionals and then craft a course responsive to those requirements. Various individuals and organizations played key roles in that process in the months that followed.

Prompted by a general officer level working session convened in the Air Force, the Joint Logistics Commanders (JLC) formed a group expressly to consider the educational needs of senior acquisition professionals. With representatives of each Service, the group worked for some 6 months to formulate a joint recommendation to the Service Acquisition Executives and the ICAF on the content for the new Senior Acquisition Course. Most notable in their final report was agreement on 11 major areas for which the JLCs believe senior leaders and managers in the acquisition field must have critical, analytical competencies. The list is particularly instructive, not so much in terms of subject area, but rather for the breadth and national level focus it reveals:

- management of risk
- fiscal & monetary policies
- environmental considerations
- decisionmaking
- international acquisition issues
- ethics
- national policy / industrial base
- Congressional relations
- evolution of acquisition
- global economy / competition
- industry motivation

At ICAF, a team was formed to incorporate these and other inputs into the design of the new course. A curriculum subcommittee was chartered to design the course and a prototype offering was conducted in Academic Year 1991 - 1992 consisting of students with extensive acquisition credentials and experience identified from within the existing ICAF class that year. Lessons learned from that experience, coupled with other internal and external analyses (including ongoing studies of the needs of executive decision makers and leaders by the Army Research Institute) and the JLC needs assessment, were melded to craft the purpose, objectives, and content of the new course to be offered in Academic Year 1992 - 1993. The JLCs favorably reviewed these plans in the spring of 1992.

COURSE PURPOSE & OBJECTIVES

In consultation with the USD(A), the purpose of the new course was stated in these words:

> The Senior Acquisition Course is designed to prepare acquisition professionals to function effectively and efficiently in a complex and dynamic geopolitical, economic, social, and military environment.
>
> The Senior Acquisition Course:
>
> - examines acquisition concepts and practices within a context of resource constraints that mandate comprehensive, reasoned linkages between national strategy and national resources.
>
> - provides a unique postgraduate, executive level education that integrates a special emphasis on acquisition management with studies in resources management and national security strategy.

Extrapolating from that broad charter, a set of specific objectives were crafted for the course. Those objectives call for graduating senior acquisition course students who will...

- be broadly educated strategic thinkers who understand the role of acquisition within the context of the resources component of national security strategy and are competent to make effective acquisition decisions and policies in a complex and rapidly changing national security environment.

- receive a premier education in national security resources management with special emphasis on acquisition, joint logistics, and mobilization.

- receive a program of Joint Professional Education that will prepare them to operate in a joint and combined environment and to think strategically from a joint and combined perspective.

- be integrated into the ICAF student body, composed of a balance of operators (30%), resource managers and technical personnel (50%), and civilians (20%).

- be exposed to national and international security communities and to evolving security resource management issues as they relate to acquisition.

- be fully prepared to assume SES and general/flag-level acquisition positions

The resultatant course was designed to fulfill those objectives and to meet the needs of the acquisition customer community and the nation at large.

THE 10 MONTH SENIOR COURSE

The senior PME acquisition course core curriculum has been divided into two semesters (see Figure 1). The core content is designed to meet statutory requirements for senior PME equivalency and to build the conceptual foundation for the study of national resource management policy. It includes the integrated and interdisciplinary study of national resource management through courses in political science, economics, strategic decisionmaking, strategy and warfare, history and regional studies, elements of national industrial power, joint logistics, acquisition and mobilization / reconstitution.

The curriculum consists of courses presented in an integrated mix of seminars and lectures. With a focus on active learning, it relies heavily on historical case studies -- from the Peloponnesian Wars through the Gulf War -- which are used to understand their political background, strategic significance, the policy-strategy-resource relationship, the evolution of national strategies, the acquisition and mobilization of national resources, and their relevance to today's issues. Case studies are used extensively throughout the course. The case studies are complemented by intensive student reading, writing, and oral presentations; classroom analyses; on site field trips; and a domestic and international field study program.

Fall Semester: The fall semester introduces students to the concept of National Security Strategy -- the art and science of developing and using the political / diplomatic, economic, and psychological powers of a nation, together with its armed forces, during peace and war, to secure national objectives. This semester lays the groundwork for the examination of the management of national resources in the spring semester.

The focus is on the global dimension of U.S. national strategy and the

interdisciplinary nature of decisionmaking at the national level. The domestic political system for the formulation of national security policy and the role of the United States in the international system are examined. The importance of the economic component of national power is stressed, as well as its impact on the formulation and implementation of national policy and grand strategy.

Spring Semester: The spring semester confronts major issues associated with acquiring and managing national resources in support of national strategy. The curriculum focuses on the sources of national wealth as well as the decisionmaking process used to convert those sources into the goods and services which underwrite our national security objectives with national power. The semester is built around an interdisciplinary curriculum that continues the approach characteristic of studies in the fall.

Figure 2 provides a framework for the second semester curriculum. Within that overall framework, students examine the interaction between national strategy, the elements of national power, the nation's resources and the acquisition, allocation, and management of those resources to support national strategy. Each student also selects one of sixteen industries to allow this interaction to be understood in some depth.

Enhanced Acquisition Management Studies. Class sessions have been integrated throughout the 10-month curriculum to emphasize the strategic dimensions of acquisition topics. Seminars, lectures, and case studies have been designed to challenge the students to assess current acquisition policy and practice in the context of National Security Strategy with an emphasis on "Acquisition Management in a Changing World." In addition, thirty classes have been developed for Senior Acquisition Course students. These classes assess the conditions, influences, and the stakeholders which determine acquisition policy, and encourage or hinder alternate paradigms.

A broad range of national security and acquisition experts (and critics) addressed the students. Speakers were drawn from senior level decision makers such as Gen. Colin Powell, Chairman of the Joint Chiefs of Staff, the Chiefs of each of the Services; Dr. David Chu, formerly of OSD; Mr. James Woolsey, , Director of the CIA; former Secretary of the Navy Lawrence Garrett; Gen. Tuttle, former Commander of AMC; prominent industrialists such as Mr. Norman Augustine (Martin Marietta), and Mr. Michael Bonsignore (Honeywell); other stakeholders such as Senator Bingamon (NM); key figures in the media such as Mr. David Gergen (U.S. News and World Report); experts from academia such as Dr. Barry Bosworth, Dr. Ronald Fox, and Dr. Jacques Gansler; and members of the international acquisition community such as Gen. Alain Cremieux of the French DGA.

Advanced Studies. In addition, each student selected three elective courses for intensive study (twelve-2-hour class sessions in each). A wide array of topics covering all aspects of acquisition management were offered for advanced study. These studies are designed to enhance and complement the core curriculum with emphasis on the specific needs and interests of each student. All advanced studies maintain academic rigor through student oral reports, research papers or essays. Acquisition related courses included: Government-Industry Relations; Professional Ethics for Public Officials; Senior Leadership-Power & Politics; Project Management Using Microcomputers; Planning, Programing and Budgeting Systems; Advanced Defense Contracting; Advanced Seminar in Selected Acquisition Topics; Business Ethics; Models of Program Management; International Acquisition, etc.

Research. All acquisition students undertook a major research project and produced a fully documented, scholarly paper. Topics of timely interest were solicited from throughout the acquisition community and the national security community at large for student research. Each project was overseen by a faculty research advisor.

Faculty Advisor. Each senior acquisition student was assigned a Primary Faculty Advisor (PFA) who is a Professor of Acquisition. Students are required to coordinate their advanced study choices and research topics with their PFA who approves the selections, ensuring the selections complement the student's individual goals and career needs.

STUDENTS

The Services, Defense Agencies, and the Office of the Secretary of Defense (OSD) competitively selected 37 senior civilians and military officers to attend the Academic Year 1992 - 1993 program which began on August 17, 1992. The breakdown is shown below:

	Mil	Civ	Total
Army	5	6	11
Navy	4	5	9
Air Force	9	1	10
Marines	1	-	1
OSD/Agencies	-	6	6
Totals	19	18	37

Beyond the numerical breakout, a number of other descriptive indicators lend some insight into the composition, credentials, and experience of the first class.

Gender:

men	31
women	6

Highest degree held:

doctorate	3
master	32
bachelor	2

Military vs. civilian & grade level:

	Mil	Civ
O-5 / GS-14	13	3
O-6 / GS-15	6	15

Years of Acquisition Experience:

Range: 3 years to 20 + years
Average: 10 years

Graduates of DSMC:

PMC graduates - 11 (of 37)

What these numbers alone do not reveal is the rich background in experience that the individuals selected for the senior course bring to this program. As a group, they include program managers, interim-level policy makers, and practitioners from most facets of acquisition management. Their years in the business come from stints in program offices, acquisition management and oversight staffs, and the various power corridors of Washington. In short, these students are promising senior members of the professional acquisition workforce.

PRELIMINARY FINDINGS

While the first class of the senior acquisition course graduated only recently, observations and interim assessments from throughout the 10-month program permit some tentative though preliminary conclusions about results.

Credentials: In terms of experience and credentials, the first 37 students selected for this program compare favorably with other competitively selected students in senior PME.

Performance: The students in the senior course performed at a level on an equal par with other students enrolled in the regular ICAF curriculum. Some competed favorably for designation as "distinguished graduate."

Depth vs. Breadth: Results are mixed here, though favorable in either case. Some used the options available in research and electives course offerings to probe deeper in areas commensurate with their entering area of expertise in acquisition. Others used the 10-month program as an opportunity to briaden their horizons in some new facet of acquistion management or some broader, related aspect of national security management.

Integrated Classes: Nearly all students and faculty reacted favorably to having students in the senior acquisition course fully integrated in core curriculum courses with other ICAF students. The interaction with students from operational, logistical, and other support communities appears to have enhanced the acquisition students debate of difficult issues within the larger context of which they are a part.

Separate Acquisition Classes: Segregating senior acquisition students only for their spring core curriculum course in Acquisition Management carries both strengths and weaknesses. On the positive side, senior course students are able to rapidly move to sophisticated levels of debate in a curriculum specifically tailored to their advanced levels of experience. Conversely, those ICAF students with lesser or no experience in acquisition are able to cover acquisition issues at a level more suited to their needs. At the same time, those students with lesser experience are somewhat limited in their interaction with senior acquisition participants -- peers with whom adult education theory suggests a great deal of learning occurs. Moreover, senior course students in class by themselves are often denied the tough, challenging questions those less familiar (encumbered?) with the business sometimes pose. And there is the occasional hazard of segregated senior course students "talking acronyms" or becoming submerged in details with one another to the detriment of rising to the national level context of debate desired.

Civilian Workforce Career Issues: While members of the civilian workforce have participated in senior PME in increasing numbers in the past decade, their participation in the Senior Acquisition Course in still greater numbers raises several potential acquisition career management issues:

- Selection Criteria. What criteria should the military departments and other defense agencies use in competitively selecting promising senior civilians for attendance at this course? The military has a long history of stringent PME selction criteria for uniformed officers followed by functional career progression through various levels of achievement. At a time when civilian career management for acquisition professionals has begun to mirror that military process, it seems critical that similarly clear and stringent criteria are crafted to sustain the exceptional quality of civilian professionals who participated in the first course.

- Career Enhancement. How will defense acquisition career managers insure that a 10-month absence from the civilian workplace becomes a positive step forward in a progressive, advancing civilian career path. Moreover, since the Senior Acquisition Course is not a mandatory course (no senior PME course is mandatory; rather they are designed to be executive-level educational experiences for a small, highly select number of potential general / flag / SES contenders), how will attendance help assure an equitably competitive opportunity for career ascension in the civilian acquisition community?

THE FUTURE?

The first year's experience with the new Senior Acquisition Course is just that -- a first experience. It is a point of departure for refinement and evolution.

Student enrollment is projected to increase frcm present levels to 76 by 1995.

Course content will undoubtedly be shaped by internal and external forces and the multipolar stakeholders which comprise the acquisition community as well as those charged with its oversight. The continuing challenge will be to refine customer needs, engender intellectual innovation, foster enlightened executive acquistion leadership, and ultimately insure customer responsiveness, both to the members of our armed forces and the nation's taxpayers.

The Senior Acquisition Course
Two Semester Curriculum Plan

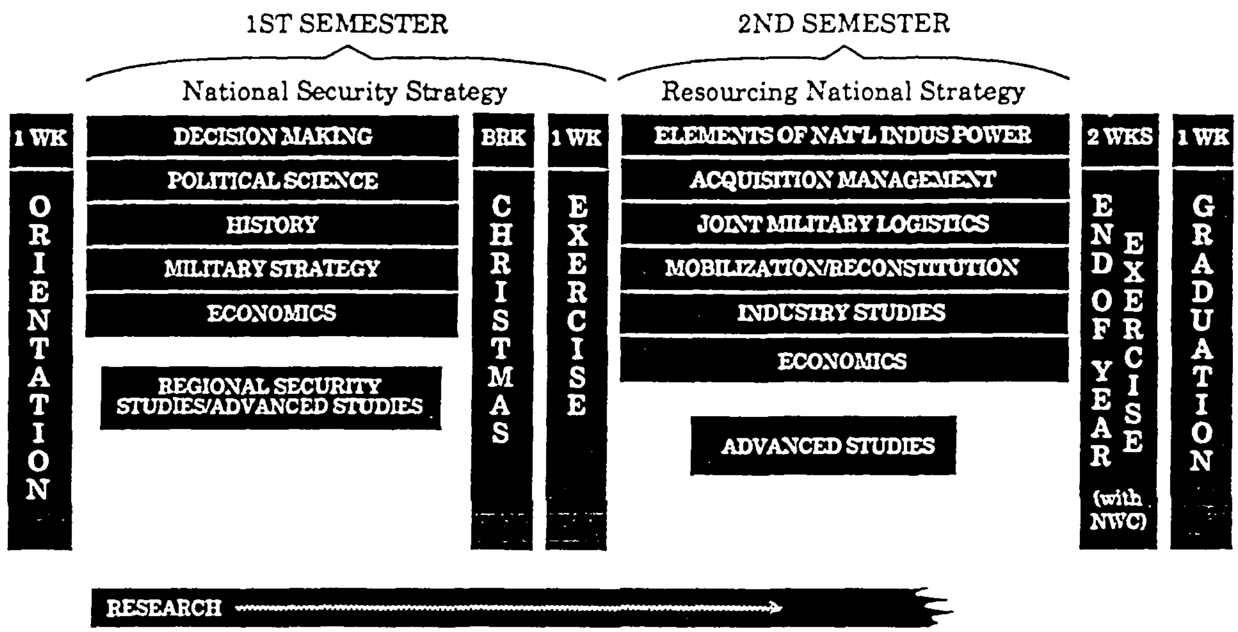
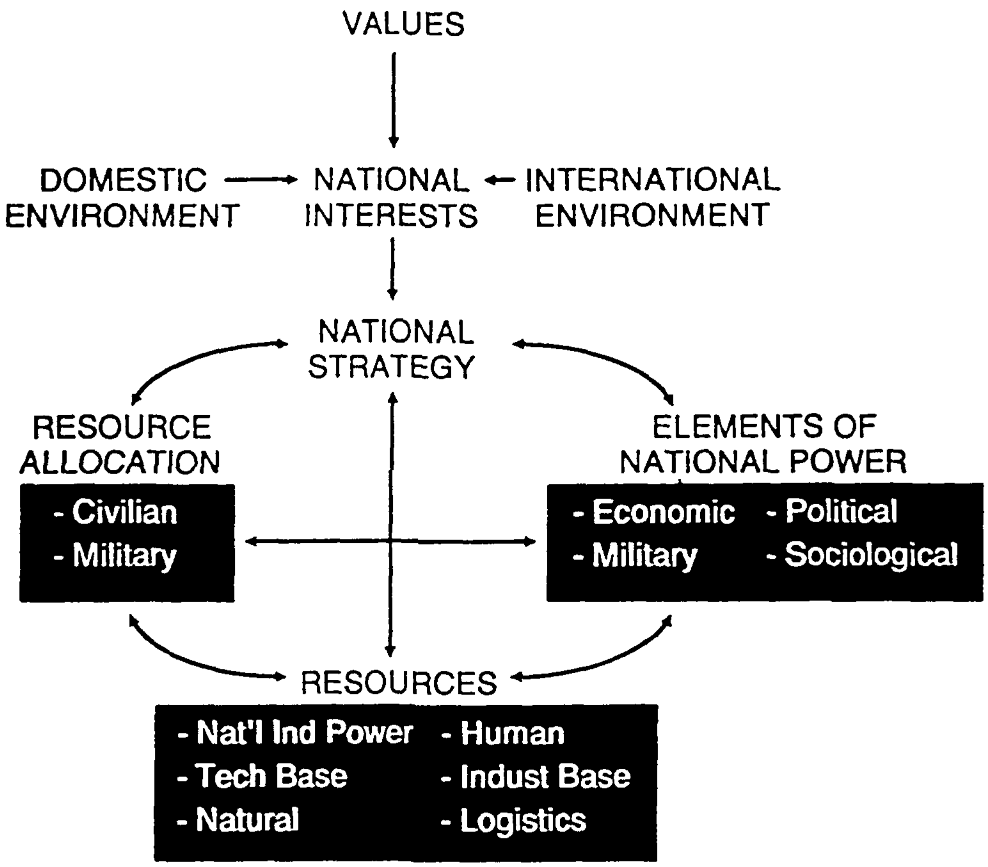


FIGURE 1

FRAMEWORK FOR RESOURCE MANAGEMENT



D31-1836-004

SALVAGING THE DEFENSE INDUSTRIAL BASE

Lawrence Briskin, United States Air Force

ABSTRACT

The United States defense industrial base has been in various stages of decline for the last 45 years. It has been part of the erosion of the industrial base of the entire nation. The process has accelerated in the last 12 years.

With the winddown of the Cold War and a final conclusion of World War II, as witnessed by hostilities long repressed in Europe and the former Soviet Union, responses once deemed undesirable, have suddenly become available.

Appropriate action in the defense arena is doubly critical. The loss of manufacturing capability already experienced, is about to be compounded by loss of manufacturing orders due to the drawdown.

The United States is now in a position to respond with appropriate actions with regard to either the defense industrial base or the entire economy. This paper examines some responses with regard to both, weighing the pros and cons of each.

INTRODUCTION

"Computer chips, potato chips, what's the difference? They're all chips. One hundred dollars of potato chips and one hundred dollars of computer chips are both one hundred dollars." Michael Boskin, Chairman of the President's Council of Economic Advisors, 1985 [10].

The United States has been in the process of deindustrialization since World War II. Part of the process has been a result of the end of the Cold War. Part has been the result of an organized campaign by our trade competitors.

When World War II ended the United States was the unquestioned dominant economic and military power. It was natural that other nations gain relative economic strength as a result of their recovery. By 1970 the combatants had fully recovered.

Though the U.S. still had trade surpluses, the continuing peacetime decline of American industry could no longer be traced to the recovery of the world from the war. The year 1970 began the accelerated decline in American industry continuing to this day. Our trade deficit began to grow. There was no growth in manufacturing employment. Meanwhile the American economists and our government continued to preach the benefits of free trade.

A strong military posture was necessary because of the continuing Cold War. A strong defense industrial base was the natural adjunct. With the winddown of the Cold War and the psychological conclusion of World War II, following the dissolution of the Soviet Union, remedies considered questionable have suddenly opened.

The U.S. economy is closely intertwined with that of the world. Therefore it is necessary to treat the issues from two aspects, the relationship of the world economy to that of the U.S., and the relationship of the civilian U.S. economy to the defense industry.

PROBLEMS IN THE GENERAL ECONOMY

The decline of the general economy is easily measured. In 1970 the population of the United States was about 200 million. There were about 24 million persons employed in manufacturing. In 1990 the population of the United States was about 250

million. There were still about 24 million persons employed in manufacturing [5]. In other words, the population had grown by 25 percent but the number of people employed in manufacturing has remained unchanged. Figure 1 illustrates. Thus, net goods to supply the 50 million person population growth are being imported. This represents goods to supply 20 percent of the current population. There has been a productivity improvement in U.S. manufacturing, but not nearly enough to account for the no job growth in manufacturing.

If manufacturing employment had grown along with population, there would be 25 percent or 6 million more people employed in manufacturing. The additional unemployed also represent thousands of factories which no longer exist.

It is true that there has been substantial growth in the non-manufacturing sector, but jobs in nursing homes, fast food, and discount houses pay little more than the minimum wage. They contribute nothing to the industrial base.

Compounding the long term problem is the current drawdown of the military services. Not only are hundreds of thousands of persons being separated from the services, but production of new weapons systems is being slowed or cancelled, affecting the defense industrial base in terms of factories and people.

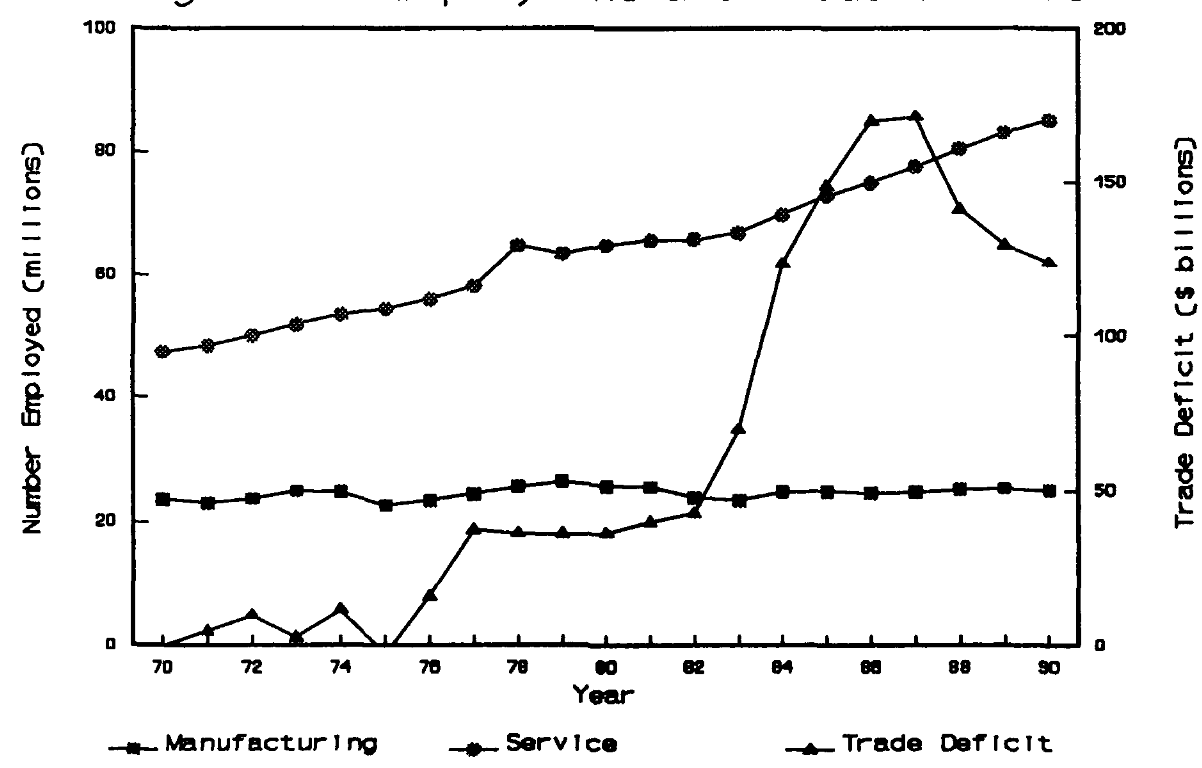
What do we do now?

THE FOLLIES OF ADAM SMITH

By dividing the problem into components it is possible to deal with each. The long term civilian problem may require different solutions than those for the defense industrial base.

Problems with the general economy may be traced to American economists in

Figure 1 - Employment and Trade Deficit



their blind adherence to the teachings of Adam Smith. Whatever the merits of Smith-'s arguments with respect to competition within a nation, they have serious faults in today's world of international trade.

Smith developed his argument by analogy. If a tailor and shoemaker are each making both shoes and clothing for their own need, they would be wealthier if the shoemaker made shoes only, the tailor clothes only and they traded. The implicit assumptions are, that they were fully employed prior to manufacture for trade, that both need and want more goods, and that the science of economics will assist them in decision making.

Under the first assumption, if the tailor increases the manufacture of clothing, he must reduce the manufacture of shoes. When he reduces the manufacture of shoes, this leaves an opening for the shoemaker to sell him shoes.

Under the second assumption, the tailor would like to have more shoes and/or clothing. He doesn't have as much as he wants or needs.

Lastly, all goods are in short supply and the science of economics will help us make and distribute them.

Even if these assumptions were realistic for the tailor and the shoemaker, they need not be true for national economies.

HOW LEVEL IS THE PLAYING FIELD?

Do labor rates count?: Many countries that have large trade surpluses with the United States, have much lower labor rates. These include Mexico, China, Indonesia, Brazil, Thailand, and many others.

Standard theory recognizes that every element of cost contributes to the ultimate selling price and competitiveness of a product. Because U.S. labor costs are substantially higher than in these nations, American goods could never compete on a head-to-head basis, if the productivity in the United States is not substantially higher than in these nations.

When faced with this issue the typical textbook response is that higher American productivity more than compensates for lower foreign wages. Unfortunately this analysis is faulty.

Taking Mexico as an example, it is true that American productivity is higher than Mexican. If Mexicans were only 80 percent as productive as Americans, and wages were the same, the textbook response would be correct.

However Americans are paid substantially more than Mexicans. If Americans were paid four times the Mexican wages, then Mexican goods would cost significantly less than American. Computing costs:

$$(\$/\text{hr})/(\text{unit}/\text{hr}) = (\$/\text{unit})$$

In the United States:

$$\$8.00/10 = \$.80$$

In Mexico:

$$\$2.00/8 = \$.25.$$

Mexican goods cost 25/80 or 31.25 percent of American goods. Under these circumstances American industry has been doing the rational thing, moving wholesale to Mexico and other Third World nations.

Japan is another critter. The Japanese through the Ministry of International Trade and Industry (MITI) systematically encouraged the formation of *keiretzus*. *Keiretzus* are industrial combinations similar to what we call trusts. Keiretzus would be illegal in the United States. These large combinations then compete with individual American companies [12]. The situation becomes American Computing Company XX vs Japan Inc., hardly an equal competition.

DOES FREE TRADE EXIST

Many economists still hold to the doctrine of free trade. They cling to its implementation through the General Agreement on Tariffs and Trade (GATT). Unfortunately the GATT system has been engulfed in a daisy-chain of negotiations. The GATT consists of over 200 treaties leaving room for negotiation, delay, and evasion. The Uruguay round of GATT negotiations has been going on for six years.

Recently the United States and Canada entered into a Free Trade Agreement (FTA). The FTA is over 1000 pages long. The proposed North American Free Trade Agreement (NAFTA) with Mexico is more than 2000 pages.

Contrary to the laissez-faire approach implicit in free trade, Japan and others have engaged in export drives deliberately building large trade surpluses. "'In my time, our job was simple,' says Naohiro Amaya, a former MITI official and an architect of Japan's postwar economic miracle. 'We had only to solve a single equation' - how to promote exports [8]."

It seems that free trade is a highly managed process, going nowhere. Free trade does not exist. It's time to rewrite the rules.

COLD WAR RESPONSES

Eckes showed that a substantial portion of the loss of the industrial base has been due to a deliberate sacrifice of American international trade to political considerations attendant on the Cold War. "For 45 years a succession of presidents, beginning with Harry Truman, have consciously subordinated domestic economic interests to foreign policy objectives. To strengthen free world economies and help contain Soviet expansionism the executive branch has rolled back tariffs and removed trade restrictions, opening the giant American market to the world's manufacturers [4]."

The Cold War is over. These tradeoffs are no longer necessary. Responses formerly not considered reasonable are now feasible.

NEW RESPONSES

The shrinkage of the defense portion of the U.S. industrial economy has been part of the contraction of the overall industrial base. This is now being compounded by the drawdown of the military services and attendant additional loss of military contracts due to the end of the Cold War.

Resolving issues of the overall economy will go a long way towards restoring the defense industrial base.

The loss of significant portions of steel, autos, machine tools, shoes, clothing, telecommunications, computers, computer chips, copying machines, televisions, VCRs, toys, etc., to foreign suppliers has weakened the overall economy and defense.

Solutions can be broken into two parts, the overall economy and the primary defense suppliers. By overall economy we mean steel, autos, machine tools, shoes, clothing, telecommunications, computers, computer chips, copying machines, televisions, VCRs, toys, etc., products which are useful in both the civilian and military sectors. The overall economy is a support structure for the defense industrial base.

Primary defense suppliers are contractors directly making weapons systems, such as General Dynamics, McDonnell Douglas, General Electric, Pratt and Whitney, etc., manufacturers and assemblers of guns, missiles, tanks, airplanes, and ships. In addition, manufacturers whose products are direct components of weapons systems may be considered primary defense manufacturers.

We first deal with the overall economy.

RECIPROCITY

The first consideration is reciprocity. The United States must demand and obtain full reciprocity in all trade matters. The Cold War is over. There is no longer a need to sacrifice our economy to maintain the support of our allies. Any rights and privileges already granted foreign nations and companies, without full reciprocity for the United States, here and abroad, should be withdrawn.

If American companies cannot buy into foreign companies, such rights should be withdrawn from foreign companies. Where granting reciprocal rights, because of the relative size and quality of the markets, would lead to an uneven exchange, to the disadvantage of the U.S., such reciprocal rights would not be granted.

Recently a major defense newspaper advocated that foreign interests be permitted to buy into American defense contractors [13]. Since such rights are not granted U.S. companies elsewhere, such buy-ins should not be permitted here.

TARIFFS AND THE VCT

Tariffs have been anathema for the last 60 years, particularly since World War II. This has been a legacy of Adam Smith and "free trade." However they must be considered in a less restrictive manner.

Discussions of trade issues have been poisoned by one word, "protectionism." It has been confused with another word, "mercantilism." Mercantilism is the practice of attempting to build the largest international trade surplus possible. In Smith's time it was measured in gold accumulated in the national treasury. He rightly condemned it.

Tariffs were an important part of mercantilist policy. Thus tariffs have historically been condemned as part of mercantilism. The use of tariffs to "protect" domestic industry began to be called "protectionism." Protectionism became a dirty word, used in place of mercantilism.

Paradoxically, mercantilism is now respectable. It masquerades under the name "export drive." Japan, South Korea, Taiwan, Hong Kong, Singapore, Brazil, China and other major trading nations are all practitioners, meanwhile professing free trade. The purpose of modern mercantilism is less the hoarding of gold, than the hoarding of industry and jobs. We might call it "job mercantilism."

If a nation is inundated by imports as a result of foreign export drives, its own industries threatened, and it responds with tariffs, it is condemned as protectionist. It has become wrong to protect yourself if attacked.

Tariffs need not be part of a mercantilist policy. They can be used to defend against the mercantilism of others. They shouldn't be condemned if used in this manner. A nation with a large trade surplus which maintained high tariffs might be condemned as mercantilist. One with substantial trade deficits is justified in using tariffs. The alternatives are quotas, voluntary export restraints (VERs) and other gimmicks. Even free trade proponents consider tariffs to be superior to these contrivances.

Tariffs are a tool. They can be used as part of an export drive or they can be used to defend against the export drives of others. In the first case they are a mercantilist device and rightfully condemned. In the second case they are justified.

The air would be cleared if "protectionism" were dropped from the vocabulary of economics. If mercantilism is meant, it should be used. Tariffs should be accepted for what they are, a tool which may be well used or ill used.

THE VARIABLE COMPENSATORY TAX

Free trade doesn't work. Mercantilism and export drives are to be condemned. An industrial policy has little chance of success in the United States. What should be done?

A Variable Compensatory Tax (VCT) has been proposed [3]. It is a system of self-adjusting tariffs used to balance trade. It would bring U.S. trade into a relative balance as follows:

$$-.05 \leq (E-I)/E \leq +.05$$

where E is exports and I is imports.

To initialize the system, first all existing tariffs and other trade barriers except health, environmental protection, and safety would be removed. Then an across-the-board tariff of 10 percent would be applied to products of nations with which the U.S. has been more than 5 percent in cumulative average deficit over the last five years. This would avoid a new flood of imports attracted by the sudden removal of other trade barriers. Figure 2 illustrates.

Each year the U.S. cumulative average five year trade balance would be reviewed. If more than 5 percent in deficit, the tariff, against all products of nations with which the U.S. is more than 5 percent in deficit, would be raised by 5 percent. If 5 percent or more in surplus, the VCT would be reduced by 2 percent against all products of nations with which the U.S. is 5 percent or more in surplus.

No action would be taken towards nations within the ± 5 percent limits. Five year cumulative average balances are used as the annual measure of the U.S. balance to stabilize the system and even out peaks.

There are other options, but they all require picking and choosing industries to be protected, and selecting a method and level of protection. These present very difficult issues and open the way for political rather than economic solutions.

WHAT WOULD THE VCT DO?

The objective of the VCT is to bring U.S. trade into, and maintain it within, a balance of $\pm$ 5 percent. It is simple and self-enforcing. There would be at most 150 tariffs, one for each nation. No new bureaucracies are needed to implement it. In fact the Department of Commerce could be shrunk by several thousand persons, now used to manage our chaotic trade laws.

The VCT is a cybernetic process, thus self-correcting. The more foreign nations bought here, the more they could sell; the less they bought, the less they could sell. The VCT would automatically control quantities by adjusting the tariff up or down, according to changes in the trade balance. Thus any attempt at retaliation by our trading partners would be self-defeating.

As a side effect, the VCT would bring back the industry and matching 6 million jobs which have been exported in the last 20 years.

In addition, it has the potential to yield up to $70 billion in revenue, helping reduce the federal deficit. During the 19th century the tariff was the chief source of federal revenue. Far from harming the U.S., during that period it built the mighty industrial machine now under severe pressure.

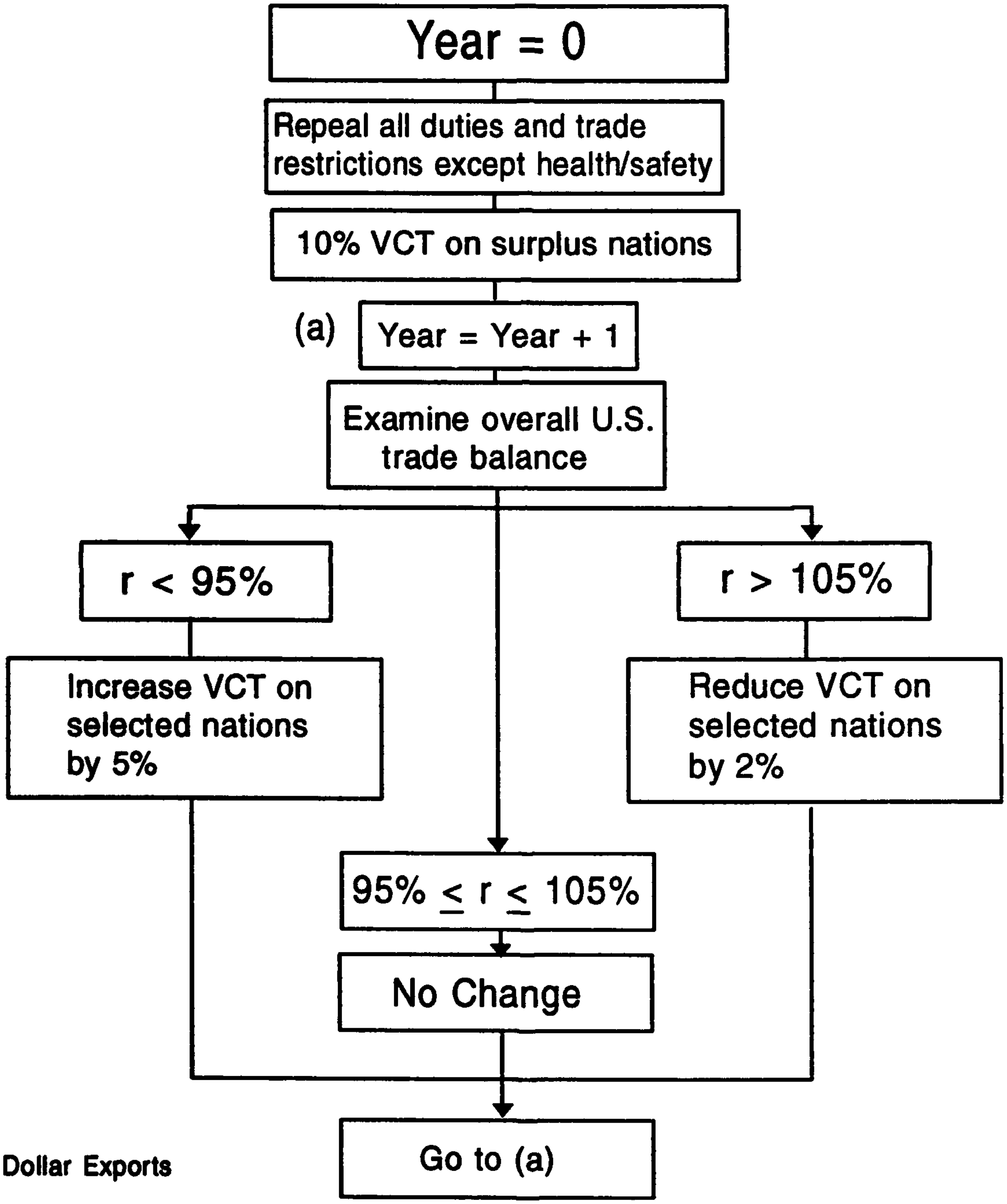
WOULD AMERICAN PRICES GO UP?

Not necessarily. The price of goods depends on many factors including profits, the costs of labor, raw materials, transportation, taxes, and overheads. Many of these are volume dependent. If there is sufficient volume more mechanization is justified. This reduces the unit cost of labor.

In addition another phenomenon takes place, learning. As managers and workers learn their jobs, they become better

Figure 2

Trade Management Diagram



$$r = \frac{\text{Dollar Exports}}{\text{Dollar Imports}}$$

at them. Production lines are shortened. More mechanization and automation is introduced. The company learns how to use cheaper raw materials. As volume increases the industry comes down the learning curve. Costs and prices also come down.

When huge volumes of steel, autos, machine tools, shoes, clothing, telecommunications, computers, computer chips, copying machines, televisions, VCRs, toys, etc., and other home and business electronic industries are repatriated, foreign companies will lose significant production volumes. American companies will gain them. As American costs and prices come down, foreign ones will go up. American manufacturers will become more competitive both at home and abroad.

Even if some American prices are not fully competitive, our international trade will not suffer. If U.S. steel prices are higher than they otherwise might be, affecting American car prices, U.S. car exports may be reduced. However if foreigners did not buy American cars, they would have to buy computers, TVs or other products if they wished to export to the United States. The VCT would automatically compensate for imbalances.

A net 20 percent of goods consumed in the United States are now imported. If employment had grown along with the population in the last 20 years, there would be about 6 million more persons employed in manufacturing. Since there has been no growth in manufacturing employment, we may conclude that the goods to supply the 50 million person population growth have come at the expense of 6 million excess Americans without jobs. *When trade came into balance, the VCT would will have brought back about 6 million jobs and the attendant industries, representing an increase of 20 percent in U.S. manufacturing capacity.*

THE DEFENSE INDUSTRIAL BASE

Our armed forces have the responsibility to be prepared for all manner of conflicts, from major wars to skirmishes. This can only be accomplished if the defense industrial base is in a position to support the conflicts which may arise.

Saddam Hussein and Iraq are still dangerous. No one knows when future tyrants, even more dangerous, will arise. The former Soviet Union and China remain potentially dangerous.

Repatriation of 20 percent of U.S. industrial capacity will provide the entire economy a large boost, including all supporting structures for the defense industrial base.

It will do little for direct defense manufacturers of guns, missiles, ships, tanks, and airplanes and many of their immediate components.

This issue is more difficult. Military equipment needs are significantly less, in an era without a major United States enemy, yet it is important that the manufacturing capability be maintained.

The Congressional Budget Office reports that the three industries most dependent upon military purchases are tank and tank components (100 percent), shipbuilding and repair (99 percent), and complete guided missiles (84 percent) [1]. Others with very high percentages are artillery and other heavy weapons, along with their ammunition.

There are two industrial sectors which can be directly supported through economic policy, shipbuilding and aircraft. Each have major civilian components. Sectors such as tanks, guns and missiles are more difficult to deal with.

SHIPBUILDING AND SHIPPING

The state of the U.S. shipping industry is measured by the following figures:

since 1947 the numbers of active U.S. flag ships has dropped from about 2,114 to 369 and the number of billets from 100,000 to 11,000. Meanwhile new construction has dropped to near zero [6,11].

The repatriation of 20 percent of the American manufacturing economy will not assure that any one sector has any particular level of operation. It is entirely possible that American international shipbuilding and shipping will continue to be almost non-existent. If after a five year period of operation of the VCT there is no major recovery in U.S. shipbuilding and international shipping, more direct measures are called for.

The simplest solution is a decision that 50 percent of U.S. international trade will go in U.S. bottoms. This means 50 percent U.S. built, U.S. owned, U.S. flagged, and 100 percent manned by U.S. citizens.

This could be accomplished by implementation of a port tax [2]. It would work as follows: All vessels would be classified as petroleum tankers, other tanker, cruise/ passenger, general merchandise, roll-on/roll-off, or other classification which may be deemed reasonable.

Each vessel, excluding U.S. intra-coastal trade, would be identified by class and size (deadweight tonnage). The port entries of foreign and U.S. vessels would be logged. To initialize the system, a $15 per 100 vessel deadweight tons, per port entry, tax would be levied on foreign vessels. This tax would be raised by 10 percent annually until the American portion of international shipping in American ports reached 45 percent of the tonnage. Existing shipping subsidies would be gradually phased out.

The tonnage would be reviewed annually. If the American portion was within a limit of 50 percent, $\pm$ 5 percent, no changes would be made. If under 45 percent American, the port tax would be adjusted upwards by 5 percent. Conversely, if over 55 percent American, the port tax would be reduced by 5 percent.

During the first eight years, foreign built ships would be excluded from the port tax, if they meet all other qualifications (U.S. ownership, etc). This would provide a period during which the newly revitalized U.S. shipbuilding industry could ramp up to the necessary production level. During the eight year initiation period, any federal shipping subsidies would be gradually eliminated.

In this manner the cost of shipping in foreign vessels would be raised high enough so that U.S. merchantmen would once again become competitive. The U.S. share of international ocean transport would vary from 45 to 55 percent.

As U.S. shipping came into balance shipyards would be revitalized and the entire U.S. merchant marine would gain a new lease on life.

Shipyards would no longer be almost 100 percent dependent on the U.S. Navy for their livelihood. If a major new naval construction program were required the facilities would be in place.

The President's Commission proposed subsidies and a host of catch-as-catch-can measures. These would end up costing the taxpayer money. A port tax would generate revenue as it brought U.S. shipping into balance.

THE AIRCRAFT INDUSTRY

Issues in the aircraft industry are somewhat different. Fortunately this industry is relatively strong compared to the comatose shipbuilding industry. However it is under attack on several fronts.

Foreign airlines have been and are buying into American airlines. Recently KLM bought 49 percent of Northwest Airlines. Air Canada is buying into Continental and British Airways tried unsuccessfully to buy 44 percent of USAir stock [9].

This has been permitted despite the lack of reciprocity [7]. An American airline would not even consider buying into a foreign one. It would be a meaningless gesture, an assault on the pride of the foreign governments and their people.

This buy-in to American airlines has ominous overtones. Though technically remaining in American control, foreign interests would ultimately be in a position to influence airline purchases. This is good news for Airbus, bad news for Boeing and McDonnell Douglas.

Not only would the civilian component be damaged, but their, and all their suppliers', abilities to support a major American airpower build-up would be diminished.

Interestingly a major defense newspaper advocated permitting foreign companies to buy into defense contractors [13].

GUNS, TANKS, FIGHTERS

Guns, tanks, fighters and similar equipment are essentially specialized to the military services. There are no civilian uses for 155 mm cannon, M1 tanks or F-16 fighters.

Production decisions with respect to these types of equipment in an era of very limited demand leave two choices, low rates of production and/or intermittent production.

If low rates of production is the selected alternative, assembly lines would kept open for longer periods of time. A trained workforce would be maintained which can act as a cadre, if it is necessary to ramp up.

If required to make engineering changes or upgrades, based on experience with early production models, there would be fewer items needing such upgrades. Since production is at a low rate, relatively few would have been produced when the new needs become known.

If higher rates of production are selected, unit costs may be lower but the assembly lines will be shut down for longer periods between production runs, carrying a risk if production is suddenly needed during a period of shutdown.

Each case must be separately reviewed, trade-offs conducted, and decisions made on an individual basis.

FMS, COPRODUCTION, TECHNOLOGY

Foreign military sales (FMS) are desirable from a cost point of view. They enable factories to maintain longer production runs, helping reduce unit costs. They also keep assembly lines open longer than otherwise. The risk is that the customer may some day turn on us, causing us to have to fight our own equipment.

Co-production is not as attractive as it may seem. If part of the component production is farmed out overseas, U.S. industry will lose the associated component production volume, negating the effect of the increased weapons systems volume. In addition it often entails technology transfer.

Technology transfer has two risks, first that the technology will be leaked to unfriendly nations, as in the Toshiba/Kongsberg affair. Secondly, it strengthens foreign commercial competitors. The commercial competitors are in competition with our own industry. American technology, paid for by taxpayer dollars, becomes a source of competition for American industry.

If either happens, it is equivalent to chasing our own tail, hardly a winning proposition.

CONCLUSIONS

Saving the defense industrial base is a doable proposition. Two sets of interactions exist: the relationship of the world eco-

nomy to the civilian industrial base and that of the civilian economy to the defense sector.

Despite the comment of a high level economic advisor to the president, quoted in the introduction, *potato chips are not economically equivalent to computer chips in the real world.* The comment reflects a cavalier attitude towards a precious commodity, our industrial base.

It has been shown that every president from Truman to Bush has deliberately sacrificed American economic interests to political interests in fighting the Cold War. The damage to the civilian economy has in turn seriously weakened the defense sector. We have become dependent on imported electronics and other goods for critical defense needs.

The Cold War is over. Approximately 20 percent net of all American goods are imported. They represent the industrial capacity of steel mills, shipbuilding, clothing, shoes, computer chips, TV, VCR and other high and low tech industry.

Some of these industries no longer exist in the United States. Others are in a greatly reduced state, weakening our overall capacity to respond to defense needs in a major conflict.

The factories are gone, the trained people are gone.

Responses which were not politically appropriate are now acceptable. By bringing U.S. trade into balance with the VCT, our industry could grow by 20 percent providing a substantial boost to our overall ability to respond to a defense emergency.

In addition, policies dealing with specific defense needs must be addressed. Given the desire, U.S. shipbuilding and shipping can be returned to a commercial success. Our aviation industry must be carefully nurtured, lest it go the way of computer related hi-tech, or worse yet, shipbuilding.

When dealing with all issues, as much attention must be given to secondary effects as to the primary. Sale of American airlines to foreign interests places the aircraft industry at risk. Co-production and technology transfer weaken U.S. industry. American tax dollars in effect fund foreign manufacturers. We end up chasing our own tails.

These issues are resolvable. Specific policies can help rebuild the industrial base, giving the support structure for the defense industry a significant boost.

Issues dealing with specialized military equipment such as guns, missiles, tanks, and fighter planes are more difficult. Problems of small production runs cannot be avoided. However extended low production rates, FMS, and if necessary mothballing production facilities must all be considered in the final trade-offs.

REFERENCES

[1] Brauer, Jurgen, and John Tepper Marlin, "Converting Resources from Military to Non-Military Uses," *The Journal of Economic Perspectives*, Vol. 6, No. 4, Fall 1992.

[2] Briskin, Lawrence E., "Free Trade Will Not Help Revitalize the U.S. Merchant Marine," *World Wide Shipping*, Vol. 51, No. 8, December/January 1989.

[3] Briskin, Lawrence E., "A Network Flow Model of International Trade," *The International Trade Journal*, Vol. III, No. 4, Summer 1989.

[4] Eckes, Alfred E., "Trading American Interests," *Foreign Affairs*, Vol. 71, No. 4, p 135-154. Fall 1992.

[5] *Employment and Earnings*, U.S. Department of Labor, Bureau of Labor Statistics, August 1991.

[6] *First Report of the Commission on Merchant Marine and Defense: Findings of Facts and Conclusions*, Sept. 30, 1987.

[7] Flam, Harry, "Product Markets and 1992, *Journal of Economic Perspectives*," Vol. 6, No. 4, Fall 1992, p 16.

[8] "Japan Economy, Built on Rapid Expansion, Faces Wrenching Shift," *The Wall Street Journal,* Dec. 7, 1992.

[9]"Marriages Made in Air," *Newsweek*, Nov 23, 1992.

[10] Prestowitz, Clyde V., Ronald A. Morse, Alan Tonelson, *Powernomics*, Economic Strategy Institute, 1991, p. xii.

[11] *Second Report of the Commission on Merchant Marine and Defense*: Recommendations, Dec. 30, 1987.

[12] Shinohara, Miyohei, "The Japanese View," in Prestowitz, Clyde V., Ronald A. Morse, Alan Tonelson, *Powernomics*, Economic Strategy Institute, 1991.

[13] "What Clinton Must Do," *Defense News,* Nov. 9-15, 1992, p 18.

DISCLAIMER

The views expressed are those of the author and not necessarily those of the United States government, the United States Air Force or any of their agencies.

c:\trade\salvage.wp

CAN WE SIMPLIFY HOW WE MEASURE SUPPLIER PERFORMANCE?

by JT Carr, Structured Methods Applications Company

ABSTRACT

By combining creativity and research, results indicate that one can simplify the method by which suppliers and sub-contractors are measured. This paper describes several examples of measuring supplier performance. The message is three fold.

First, a performance criteria, that rewards productivity, teamwork, and entrepreneurship, can be standardized for both customers and suppliers. The difference is in how it is measured. Second, offering something free that is of value to the customer serves as a first indicator of service. Third, the second indicator is productivity - in terms of knowing the processes or steps, and in terms of specific repeatable techniques, is neither well understood, nor practiced, nor measured nor rewarded.

The examples range from a tire company, a training company, auto repair service, insurance company, leasing company, roofing company, to health care providers.

In all instances, simplicity and specific productivity techniques in terms of repeatable techniques or processes, were observed. The techniques and processes are described, along with measures and rewards. The risks in measuring supplier performance is that the wrong things are often measured.

Seldom is productivity in terms of processes or techniques measured or rewarded. The solution is (1) to follow a standard performance criteria and measure productivity in terms of simplicity, processes, and repeatable techniques, for both customers and suppliers, management and staff, and (2) measure the right performance. The performance that is measured will be rewarded.

INTRODUCTION

Much has been studied and written about performance measures, quality, and acquisition. But few understand what to look for and measure in determining performance in people and companies who offer service and products. How can you measure the performance of suppliers? What are the measures that determine quality performance?

By modifying a standard performance criteria (Figure 1) that rewards (1) productivity (2) entrepreneurship, and (3) teamwork, and applying this to various supplier-based research applications, similarities have been observed.

In seeking answers for "how to's" in the war against waste, inefficiency and bureaucracy, one has to examine: How are we measuring performance now? What SHOULD be measured?

The KEY to determining performance is (1) the suppliers' helpfulness in

Performance Measurement Criteria

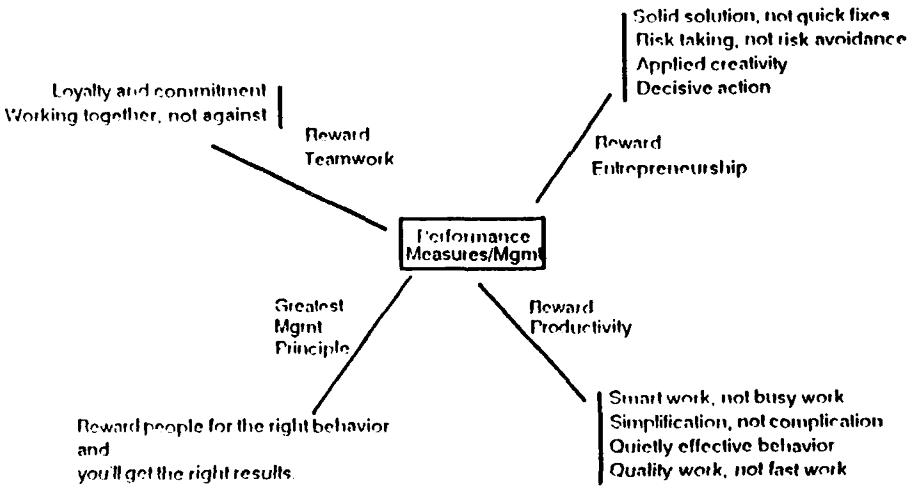


Figure 1

Source: Greatest Mgmt Principle in the World, M. LeBoeuf

meeting the customer's needs, and (2) knowledge and practice of <u>productivity skills and techniques</u>. People, suppliers of all kinds, should be measured and rewarded for using productivity techniques and processes in some way. Realizing that rewards and measures are often intricately intertwined is key to understanding and measuring performance correctly.

The most difficult part of rewarding the right behavior is determining the right things to measure. Frequently the wrong activities are measured and the right ones are ignored.

There are two steps to measuring performance: (1) offer something free that is of value to the customer and (2) seek suppliers who use some productivity techniques that offer savings of effort and money to the customer. Let's examine them briefly.

<u>Offer something of value free to the customer</u>: The key here is understanding what the customer needs in order for the offering to be of value to them. It's the little things that count.

People seeking service and/or products of any kind- whether it be roofers, consultants, lawyers, health care providers - should seek and listen for ways the supplier can save them money, time, or effort. An effective supplier should inform and educate the buyer by providing simple, helpful, valuable information - provided freely- which assists the buyer in being a more informed purchaser and meeting his needs, be they large or small. Something offered freely <u>must</u> be of value to the customer. If it is offered freely but is not of value to the customer, the free offer will not be effective. Getting

to know the needs of the customer- through the process of listening within the process of negotiation - is the first key to identifying quality supplier performance.

Services of value to the customer can only occur by listening to the customer and determining what might be helpful to meet his needs. Effective listening to "where the person is coming from" and "needs" would help the supplier provide small yet extremely important free services, ...key to establishing oneself as a quality supplier.

Example: Melissa, an 11 year old, went to a tire company with her four quarters to buy an inner tube for sledding. When the tireman heard her request, he found a rumpled tube, cleaned it up, filled it with air, and gave it to her freely.

Comment: This example of something offered freely to meet the customer's needs is the first indication of service and good will.

Example: A training company offered free registration to this author to attend an out-of-town class on planning. Since the customer (this author) teaches planning, this free offer was of little value. A textbook was offered as part of the course and the customer would have liked a free copy of the text. An earlier request for a free review copy was denied.

Comment: Had the course provider agreed to send a free copy of the text, the "free book" gesture would have been less expensive in dollars for the supplier and more valuable to the customer. It is the responsibility of the supplier to listen to the needs and requests of the customer and respond to those needs, or attempt the negotiating process by offering alternatives. Frequently customer requests and solutions are more simple than suppliers might imagine.

COMBINING FREE WITH SIMPLICITY

Occasionally, something offered freely is combined with simple solutions. Consider the following...

Measure: Simplicity. Customer service. Free.
Reward: Productivity.

Example - Auto Part 1: They were leaving on a weekend trip. The driver did not have time to check out the car. She drove into a gas/repair station and asked the mechanic if he could check out the car for the trip. He explained the major areas to be concerned about, checked the fluids, and okayed the car for the trip, in about 5 minutes. Given the length of the trip, the mechanic explained that this quick check was adequate to assure the driver and passengers that the auto was in good condition for the weekend trip.

Comment: This quick and efficient assessment, given the parameters provided by the customer, provided valuable free information for the customer's needs at hand.

Example - Auto Part 2: The tire was very low, possibly in need of replacing. When the mechanic evaluated the tire, he found a leak in the rim/tire. The mechanic suggested: (1)

replace the rim/tire or (2) insert an inner tube in the tire. The dollar savings in the simpler choice was about $40.00.

Comment: By offering the customer choices, one of which being a low cost, simple solution, the supplier is illustrating simplicity. Often, quick fix, simple solutions will suit the needs at hand. It is important for the supplier to understand the requirements and limitations affecting the customer and offer simple, often creative low cost solutions and choices that work. Is it really necessary to calculate in dollars and minutes the savings? Isn't the goal of quality to meet the customer's needs? If needs are met, must we measure further?

Measure: Simplicity. Something written. Customer service.
Reward: Productivity. Teamwork. Creativity.

Example: A fire insurance policy was cancelled on a Florida rental property. Discussions from Seattle with an independent agent suggested a complicated and expensive solution. Another agent suggested a simple solution: "send me a photo of the property, confirm that it has been rented, and the policy can be reinstated." The agent offered to contact the mortgage bank and coordinate information and efforts. Simple. Cooperative.

Comment: Seek suppliers who offer streamlined, simple solutions. Seek suppliers who offer to do something extra as a way of offering customer service, perhaps by contacting others to make it easier for you, the customer. Look for simplicity and teamwork and reward it. The agent was rewarded with "praise" for her assistance and simplicity in solving the problem via a "thank you" call from the customer.

WHAT IS PRODUCTIVITY?

What is productivity? It is neither well understood, nor practiced, or measured, or rewarded consistently. In addition to simplicity, productivity includes:

* smart work, instead of busy work
* quality work, instead of fast work.

* Smart work instead of busy work: In these complex busy times, we can no longer continue to work the same way as we have in the past. We need to think creatively before we act, find new methods to accomplish work, and find new uses for existing resources. We need to streamline efforts, and reward people who give thought to, suggest, and implement ways to lessen work, while maintaining high quality by eliminating errors and rework.

What is meant by smart work? Smart work includes productivity techniques which, although simple, are frequently neither practiced nor measured nor rewarded. Productivity techniques (Figure 2) such as "have more than one use for

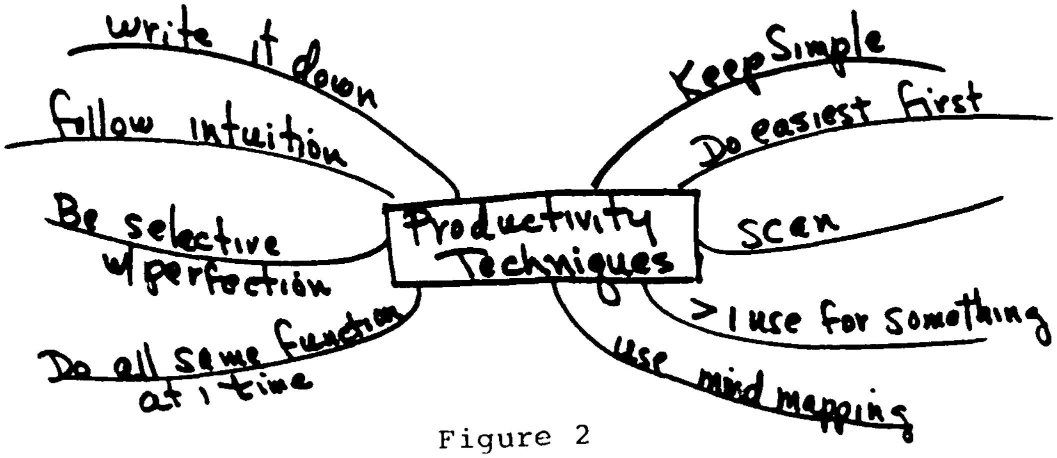


Figure 2

Productivity Techniques
in Mind Map Format

something", "put it in writing", "do the easiest first", "keep it simple", and "design with the most detailed in mind"...are techniques that should be measured and rewarded. For example,

<u>When doing or starting anything, do the easiest first.</u>
When solving problems, writing documents, developing a briefing, designing anything, do the easiest part first.

<u>Design with the most detailed in mind.</u>
After designing the easiest first, move next to the most detailed section. Once the most detailed part or section is designed, all the other parts can be modified to accommodate them.

<u>Have more than one use for something.</u>
Can a letter or document be used by more than one audience? By designing with more than one use as much as possible [documents, letters, buildings, software, bottle caps, offices, bathrooms, and other engineered efforts], effort, resources, and dollars could be saved.

<u>Consider using the mind mapping tool, whenever writing anything.</u>
Mind mapping and other idea generating tools (1) can provide a quick method of note taking and (2) can be used as a productivity tool in writing to save time and effort. Mind mapping can be used when solving problems, when gathering ideas for a WBS, when developing draft SOWs, in developing briefings, when writing anything, when being creative such as an idea generating tool, perhaps to

break the whole into parts or combining parts into whole.

APPLICATIONS USING PRODUCTIVITY TECHNIQUES

The following are examples of applying various productivity techniques by various suppliers.

<u>Measures</u>: Clarity. Simplicity. Something written.
<u>Reward</u>: Productivity. Creativity. Teamwork.

<u>Example</u>: Using the productivity technique of "have more than one use for something", Eaton Financial

Corporation uses their customer number as part of their invoice number. For example, customer number is # 0162667; the invoice number is #016266702093. This cuts down on errors and serves as a double check when problems arise. Their contracts are written in simple, clear English providing an environment of understanding and clarity, much appreciated by their customers.

Comment: Simplicity is illustrated in the clear writing they use in their contractual documents that describe in clear, understandable English the legalistic terms and conditions. Using the customer number as part of their invoice number is also creative and entrepreneurial. The customer's needs are met by these simple offerings of clear writing and understandable terms.

Rewards to Eaton Financial Corporation are in the form of "money" (more contracts) and "praise" as people use Eaton as a benchmark of excellence in modeling simplicity of terms, contracts, and invoices.

<u>* Quality work, instead of fast work, means understanding the processes.</u> Quality improvements require us to think in terms of structured processes; therefore we must seek to understand them. Structured methods deal with analysis, design and development which are at the heart of the life cycle. Structured methods or systems translate functions into a set of steps. Most everything performed has some structure to it.

Many people are implementing, managing and measuring quality improvements without an understanding of the processes, methods and their integration. Let's examine these processes briefly.

> <u>Life Cycle Process</u> (Figure 3): There is a distinct difference between the product to be developed and the process that builds the product. The process that builds the product is the Life Cycle process whose steps can be simplified to: Define, Design, Develop and Deliver. Sometimes the phases

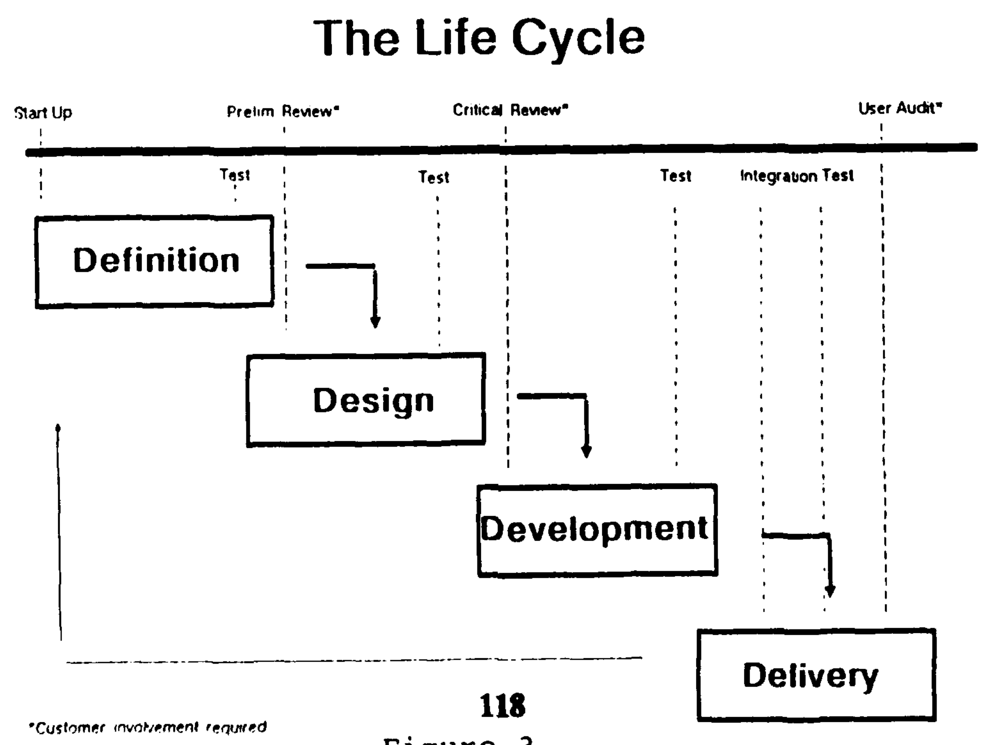


Figure 3

are understood but little attention is given to the role of the customer, people skills and processes, and the value of Preliminary, Critical, and System Design Reviews. Untangling the (1) process of building the product (life cycle) with (2) the process of planning and controlling the work (planning and controls process)...would assist managers in feeling more secure in understanding how to structure and manage their work and how this work fits into the bigger picture.

Sometimes these life cycle processes occur very rapidly and so simply that we are not even aware of the process.

Measure: Simplicity. Reviews. Tests.
Reward: Productivity. Teamwork. Creativity.

Example: She had a recurring inflammation on and around her exterior ear. Various OTC ointments were applied with little success. Another pharmacist listened, and suggested that a stronger OTC ointment be used, offering reasons why previous therapy may not have worked. The remedy was tried; the problem was resolved almost overnight.

Comment: The pharmacist used several productivity techniques: "keep it simple", "do the easiest first", and offered free valuable advice. The pharmacist explained why the remedy may not have worked earlier - valuable information, modified the course of action, and recommended a simple, easy solution to try. From the patient's point of view, this action was also a progress review, in the life cycle of solving this recurring ear problem, where the problem solving process, plus additional facts from the new team member-supplier (pharmacist), led to modifying the course of action, and testing the results. The pharmacist suggested a "simple", "easiest first" work-around plan solution which worked.

> Planning and Control Process (Figure 4): The process of planning and controls is an existing and effective process used within aerospace and defense. There are specific steps to this process. It is integrated with and is a part of the life cycle process. These steps- SOW, WBS, schedules- if structured correctly, can be measures of quality in the planning process. Every time *work has to begin or* an assignment is given to anyone, the planning and control (or monitoring) process begins. The process already exists and the steps are defined. Perhaps some tailoring might be necessary for a specific application.

The planning and control process should be used by managers, self empowered teams, contractors, subcontractors ...all people ...when planning is needed. These same steps can serve both as performance measures, and communication tools for staff, leaders, including people measuring the performance of suppliers.

Measure: SOW, WBS, Schedules, and other documents as needed
Reward: Productivity. Teamwork. Entrepreneurship.

Example: Dr. Alan R. Carr, an orthodontist, after the initial free introductory

Planning and Control Management System

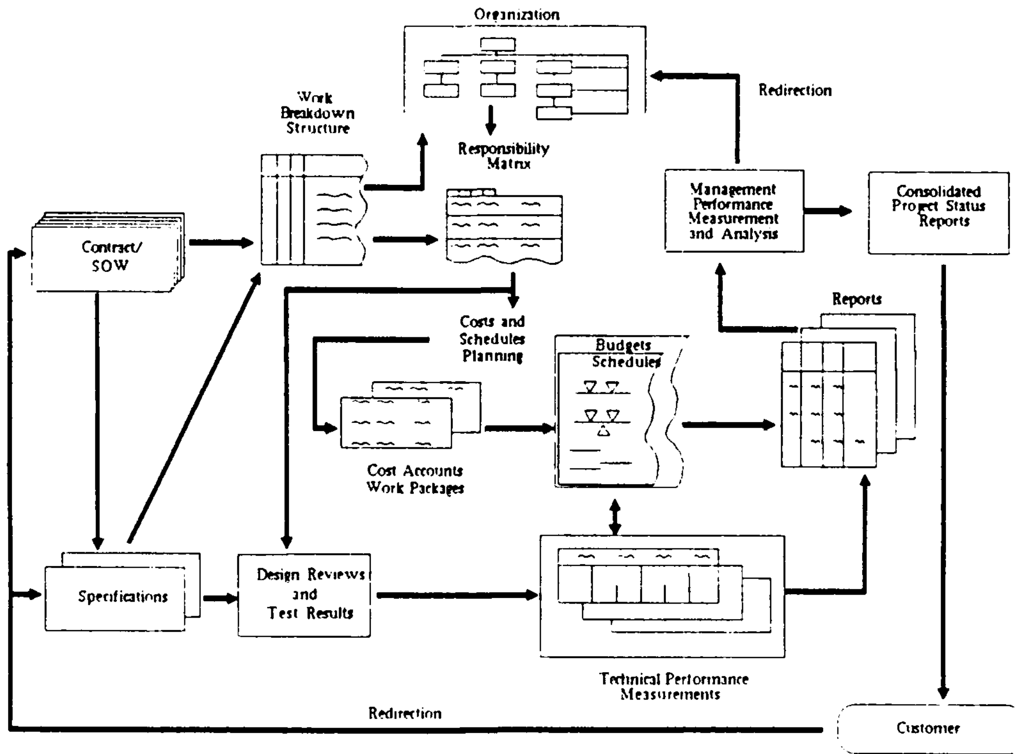


Figure 4

meeting, provides the patient with a big picture view of the orthodontic life cycle approach planned over the forthcoming years. The plan is pictorial, and explained in understandable terms. Then he develops a simple Statement of Work for his customers, that describes in broad terms what he plans to do, major milestone dates, payment terms and constraints, and responsibilities.

Signature by the customer is required confirming that both customer and service provider are in agreement. The documents and procedures he uses are kept simple, requesting details from the patient on an as- needed basis only, eliminating unnecessary duplication of data.

Fun, colored rubber bands, color coding of the charts and other administrative records, use of recycled stained glass for decoration...are some of the many examples of creativity and entrepreneurship.

His staff conducts daily stand up review meetings to assure that all staff is kept informed of specific patient needs. Information is shared. Communication is enhanced. Staff is kept quickly and readily informed of problem cases, current issues, and daily happenings. Staff has fun, shares information, works each other's functions, and is congenial with each other and the customers.

Progress is monitored by monthly review meetings (visits) with the customer where status is discussed, tests are made, modifications occur when needed, developments are discussed, and future plans are shared.

Comment: The orthodontist (1) offers a free preliminary meeting with patients to determine if he can provide an appropriate solution. After agreeing to treatment, he presents his treatment (2) using simple, pictorial documents that describe the work to be performed similar to a statement of work. He (3) conducts periodic reviews and tests examining the progress, providing status and "next step" plans to the customer, throughout the life cycle of the therapy. (4) If problems arise,

the orthodontist modifies and simplifies his approach to meet the needs of the customer, a simple, work-around plan.

This supplier offers (1) quality service based on valuable information offered freely during the preliminary meeting, (2) simplicity in streamlining the paperwork and forms, (3) clarity in terms of designing and developing the course of therapy, (4) structure in terms of statement of work-type documents in planning, and (5) customer service and teamwork seen in progress reviews and work- around plans.

> Writing process (Figure 5): Since much of the planning and control (managing) function is writing, it is important for leaders to understand that

(1) writing is a process which has structure,

(2) its outcome is a document (something written),

(3) the document must be planned and managed, (planning and controls structured process) and

(4) the document has a life cycle (Figure 6) whose development phases must be defined, designed, developed, and delivered. Note that the processes have logic and structure, repeat themselves, and are continually integrated.

Measure: Something written. Various productivity techniques.
Reward: Productivity. Teamwork. Entrepreneurship.

The Writing Cycle

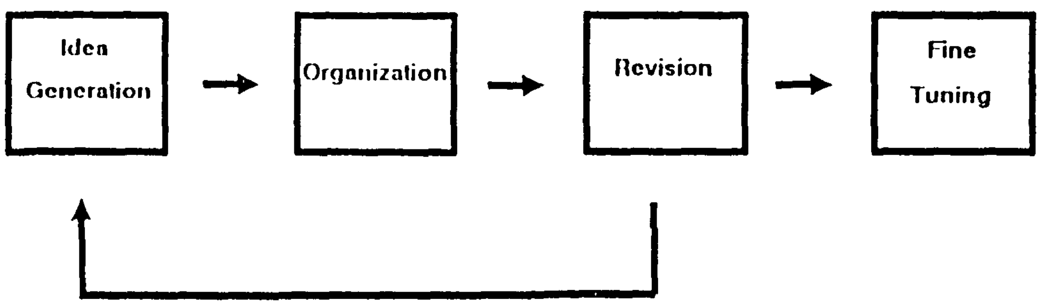


Figure 5

The Document Life Cycle

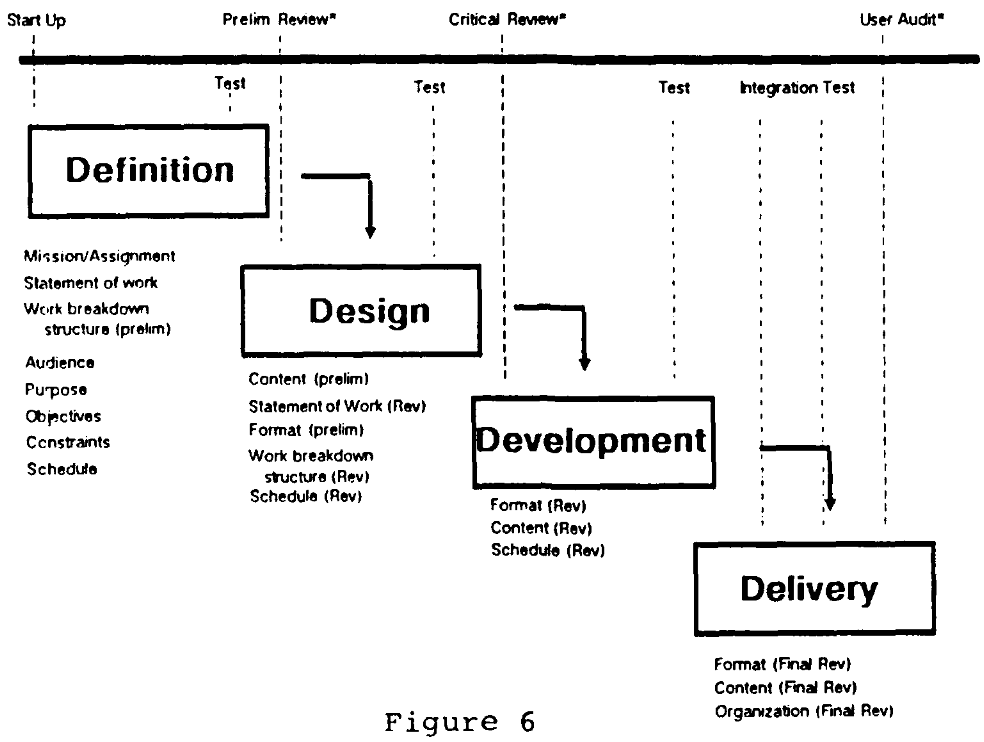


Figure 6

Example - Auto Part 3: The car would not start, appearing to be some battery-related problem. The service station mechanic evaluated the problem, called an auto electrical company, and conferred with the staff. When all else failed, the service station staff towed, with no tow charges to the customer, the car to/from the auto electric specialists, who discovered the intermittent problem was with the alternator. The auto repair dealer chose to replace the alternator at his location, using generic parts, saving the customer additional funds. The service repair owner delivered the repaired car to the office of the customer, adding that payment could be made within the next few days.

Comment: The auto mechanic -owner practiced (1) quality work - as defined in this paper under productivity- through his trial and error, modifications, and successful attempts to solve (problem solving process) the electrical problem in the on-going life cycle maintenance of the auto, (2) conducted his work around plan after several trial and error, test, review, and try again attempts to identify the solution in the life cycle of this electric problem, (3) used productivity techniques via generic parts (" have more than one use for something"), (4) practiced teamwork by conferring with electrical specialist colleagues and by providing feedback to the customer, (5) illustrated trust by requesting payment when it was convenient for the customer, and (6)

produced an invoice, written clearly, that identified and described the charges.

The customer was rewarded with quality service. The service station owner was rewarded with "money" (in terms of repeat business) and "praise". Team members (ie, electrical specialist colleagues and service station staff) were rewarded by "praise".

WRONG MEASURES OF QUALITY

Sometimes friendliness is mistaken for quality. Friendliness by itself, while helpful, is not a measure of quality. Sometimes other measures are mistaken for quality such as number of staff, spaciousness of the office, degrees and licenses earned, or universities attended. These are not measures of quality.

Example: The large, well-known roofing repair company rep was most cordial on the telephone and provided an estimate of the repair job on the rental property. The agreement was: pay half up front, and half when the job was finished. Since the customer was in Seattle, this seemed appropriate. When the customer received the bill for the work performed, it seemed to be a small amount of work for the amount charged. In seeking a better understanding of the work involved in this repair, although the repairs occurred in Florida, some roofers in Seattle were called and the repair situation was described. One supplier, when questioned, provided a rough estimate of what the job should cost.

Comment: That estimate - free, valuable information - assisted the purchaser, located in Seattle, in determining that the roofing supplier, located in Florida, was overcharging for the job. The Florida roofer was informed of this concern and invited to justify the charges. Anger was the reply received. Friendliness is not a measure of quality. Charging for "service" is also not a measure of quality. Stating, in clear understandable terms, up front, in writing, what the supplier includes in his charges, and what is excluded is a measure of quality in terms of productivity, simplicity, and clarity in speaking and writing....clear, simple terms to understand, offered up front, in writing.

Understanding that these processes are based on logic, repeatable, and standard, is paramount to understanding and recognizing the true meaning of quality work. Furthermore, understanding (1) that most everything has a process and (2) realizing, in simple terms, how these processes affect us in daily life, is important when seeking to recognize these processes in suppliers.

SUMMARY

Using a standard performance criteria that measures people on (1) productivity, (2) entrepreneurship and (3) teamwork, and keeping the measures simple and focused on productivity, quality performance in suppliers can be observed, recognized, measured and rewarded.

Too often, experts in quality seek to complicate measures. When deciding which supplier to select, ask yourself: which one makes work easier and simpler for me, the customer? Do they offer simple, creative suggestions, and provide streamlined procedures? Do they offer information freely that assists you in being a more informed purchaser? Are their documents, contracts and terms easy to read? Do they use pictures instead of text in describing their work? Are they clear? Do you invite and reward creative ideas that streamline procedures?

Is training performance measured by the size of the organization, customers who have attended, number of hours/people taught (poor measures) or number of students who have illustrated achievement (good measure) in performing the functions?

In developing software, do your contractors measure amount of lines of code written and thereby increase run time? .... or do they streamline their coding, write it in a structured fashion, in order to provide savings in maintenance, in resources, and in other ways?

The measures YOU will see will be ...(1) information or something free that is of value to you in achieving your goal as a customer, and (2) streamlined, creative, productive methods that save time, effort, resources and money. In addition to observing and asking about these measures, reward suppliers for streamlining, simplicity, and other productive measures and you'll benefit from their creativity and resourcefulness.

If performance of suppliers were measured and depended on seeking and initiating creative, simplified solutions, and in working together to seek and solve customer problems, such as the examples in this paper, more performance successes would be seen.

Ask yourself: Are you measuring and rewarding simplicity and productivity in supplier performance now? ##

Reference:
1. Research adapted from work by LeBoeuf, Michael, PhD, The Greatest Management Principle in the World, 1989, Berkley Pub, NY.

About the Author: JT Carr, President of Structured Methods Applications Co., specializes in methods and techniques for higher quality and performance and has more than 20 years experience in management. With a background in aerospace and health care, this educator-researcher has contributed to Program Manager of DSMC, Performance Improvement Quarterly, and other management-technical journals and symposiums. She has been Aerospace/Defense Chair for 1991 PMI Symposium and for 1992 PROJEXPO. Contact info: SMA Co., 5929 149th Ave SE, Bellevue, WA 98006, Tel/Fax: 206/643-6136.

THE USE OF SAATY'S ANALYTIC HIERARCHY PROCESS IN ECONOMIC ANALYSIS

Major David Christensen
Captain Jeff Battin, Captain Tom Bender
Air Force Institute of Technology

ABSTRACT

A discounted cash flow comparison of acquisition alternatives, termed "economic analysis" by the Department of Defense, necessarily focuses on the quantifiable benefits and costs. Nonquantifiable factors are much more difficult to include, but should not be ignored. Saaty's Analytic Hierarchy Process (AHP) is one way to capture both quantifiable and nonquantifiable costs and benefits by establishing relative weights for the selection criteria and relative ratings for the alternatives. This paper briefly reports the theory behind AHP and its potential application to economic analysis using an Air Force project to renovate an aircraft taxiway as an example. Despite several potential implementation problems, this decision support tool should foster a more complete, systematic, and objective evaluation of acquisition alternatives.

INTRODUCTION

When selecting a project or set of projects to acquire, both quantitative and qualitative factors are important. In "cost-benefit" analysis the benefits as well as the costs of alternative investments should be considered. Traditional capital investment models that employ purely economic selection criteria, such as net present value or internal rate of return, have been criticized for failure to adequately include intangibles [14,15]. This problem is particularly important to the Department of Defense, where qualitative noneconomic factors can dominate. Despite this, there is little guidance regarding how to include noneconomic factors in what the Department of Defense narrowly terms an "economic analysis." Department of Defense Instruction 7041.3 [7], for example, recognizes the need to assess nonmonetary costs and benefits across alternatives, but provides little procedural guidance. Air Force Regulation 173-15 similarly requires that a comparison of benefits between alternatives be formally documented for the decision maker, but devotes only one paragraph to the issue [8:9].

A multi-criteria decision model is needed that can combine quantitative and qualitative factors into the capital investment decision. The model should not replace the decision maker, but improve the capital investment decision by a systematic consideration of all relevant factors. One such model that has received significant attention and broad application is Saaty's "Analytic Hierarchy Process" [24,28].

This paper describes the Analytic Hierarchy Process and provides an example using data from an Air Force project to renovate an aircraft taxiway. Limitations and potential implementation problems are described. The purpose of the paper is to inform the reader of a viable tool for systematically including nonquantifiable factors in an economic analysis.

THE ANALYTIC HIERARCHY PROCESS

The Analytic Hierarchy Process (AHP) is a rational and systematic approach for finding a solution to a problem. The method allows decision makers to partition large unmanageable problems into smaller parts that are easier to handle. It provides decision makers with the ability to include qualitative and quantitative criteria to form a rating for each of the alternatives. These ratings may then be used as a basis for project selection.

Four steps are used to solve a problem with AHP: (1) build a decision "hierarchy" by breaking the general problem into individual criteria; (2) gather relational data for the decision criteria and alternatives; (3) estimate the relative weights of the decision criteria and alternatives using the "proportional method" or the "*eigenvalue* method;" and (4) aggregate the weights of the criteria and alternatives into a vector of ratings for the alternatives, which can be used to rank the alternatives.

These steps are perhaps best understood with an example. Here, data from an Air Force economic analysis are used. More elaborate examples of using AHP in capital acquisition problems are available elsewhere [10,22].

The decision problem was the repair or replacement of an aircraft taxiway [2]. There were three alternatives: Alternative A, repair the old taxiway; Alternative B, construct a new taxiway with material recycled from the old taxiway; and Alternative C, construct a new taxiway and dispose of the materials from the old taxiway.

The selection criteria were (1) the cost of each alternative, termed "Cost"; (2) the ability of each alternative to sustain aircraft weight, termed "Weight"; and (3) the minimization of taxiway congestion, termed "Congestion." The first criterion was quantitative, and based on estimates of a cost analyst; the other two were qualitative, and based on the judgment of the decision maker.

Step 1. As illustrated in Figure 1, the "hierarchy" is simply a tiered framework of decision elements related to the problem, with a statement of the overall objective at the top and the alternatives at the bottom. Between the top and bottom levels are relevant attributes of the decision problem, such as the selection criteria. The number of tiers depends on the complexity of the problem and the capacity of the decision maker(s) to make pairwise comparisons between the elements at each level.

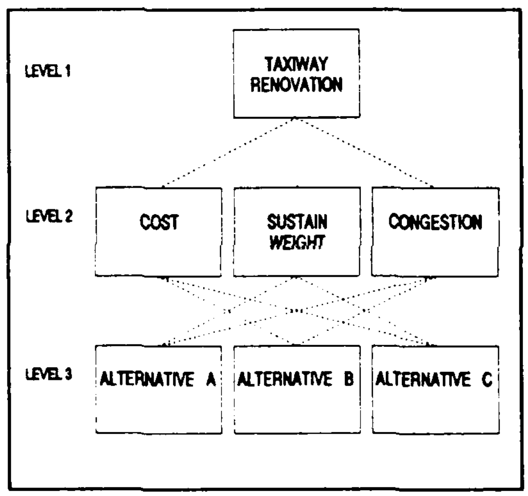


Figure 1. Taxiway Hierarchy.

Step 2. In this step, relational data for comparing the alternatives are generated. Generating quantitative data, such as the cost of each alternative is straight forward. In an economic analysis, costs are in constant dollars and discounted using a real 10 percent rate. Generating qualitative data typically requires the decision maker to

make pairwise comparisons of elements at each level in the hierarchy regarding the contribution made to the objective in the next higher level. In the taxiway example, the importance of each criterion to the taxiway, and the relative ratings between alternatives for each criterion needed to be established.

In AHP a ratio scale of real numbers from 1 to 9 is used to systematically assign the preferences. In the taxiway example, the cost criterion was considered twice as important as the weight criterion and five times more important than the congestion criterion. To facilitate the pairwise comparisons, verbal descriptions of the numerical ratings may be used. In either case, AHP software will systematically prompt the decision maker to make all the pairwise comparisons [9,16]. For each pairwise comparison, the decision maker is asked which element is most important, preferred, or likely, and by how much or how many times. Tables 1 and 2 detail the results of the pairwise comparisons.

As shown in Table 1, the cost criterion was judged to be three times more important to selecting the taxiway than was the weight criterion. Similarly, the cost criterion was judged to be five times more important to the taxiway decision than was the congestion criterion. The weight criterion was judged to be twice as important as the congestion criterion.

In Table 2, relational data derived from comparing the alternatives are shown for each criterion. For the cost criterion, the present value cost of each alternative is listed. For the other criteria, pairwise comparisons between alternatives were necessary. The relational data in the table reflect the decision maker's preferences between the alternatives with respect to each criterion, and are interpreted the same way as in Table 1. With respect to the congestion criterion, for example, Alternative A was judged to be the most desirable.

Tables 1 and 2 also show "inconsistency ratios." In the process of making the pairwise comparisons, inconsistent judgments are possible. In the taxiway example, Cost was judged to be more important than Weight, and Weight was judged to be more important than Congestion. Accordingly, Cost should be judged more important than Congestion. Otherwise, the comparison would be inconsistent.

The inconsistency ratio quantifies an inconsistent comparison. An inconsistency ratio of zero reflects perfect consistency, which is difficult to achieve when there are many comparisons. For n alternatives, n(n-1)/2 comparisons are required for each criterion. With eight alternatives, for example, 28 pairwise comparisons would be necessary for each qualitative criterion. The inconsistency ratio is thus rather useful feedback to improve the accuracy of the pairwise comparisons.

According to Saaty, small inconsistency ratios do not drastically affect the ratings by AHP. Based on experiments reported by Saaty [20] and Vargas [23], a "rule of thumb" is recommended: when the inconsistency ratio is less than .1, the inconsistent comparison is acceptable. When the ratio is larger than .1, AHP software will prompt the decision maker to redo the comparisons. Each time the pairwise evaluations are re-accomplished, a new inconsistency ratio is computed. The process of revising the pairwise judgments can help the user to discover illogical thinking and generate insight into the

TABLE 1

RELATIONAL DATA FROM PAIRWISE COMPARISONS OF TAXIWAY CRITERIA

Criteria	Cost	Weight	Congestion
Cost	1	3	5
Weight	1/3	1	2
Congestion	1/5	1/2	1

Inconsistency ratio = 0.003

TABLE 2

RELATIONAL DATA FROM PAIRWISE COMPARISONS OF ALTERNATIVES

Criterion	Alternative A	Alternative B	Alternative C
Cost	$5M	$4M	$3M

Inconsistency ratio = 0.000

Weight	Alternative A	Alternative B	Alternative C
Alternative A	1	1/3	1/5
Alternative B	3	1	1/2
Alternative C	5	2	1

Inconsistency ratio = 0.003

Congestion	Alternative A	Alternative B	Alternative C
Alternative A	1	6	4
Alternative B	1/6	1	2/3
Alternative C	1/4	3/2	1

Inconsistency ratio = 0.000

TABLE 3

NORMALIZED WEIGHTS AND RATINGS

Criteria (Weight)	Alternative Rating		
	Alternative A	Alternative B	Alternative C
Cost (.648)	.255	.319	.426
Weight (.230)	.109	.309	.582
Congestion (.122)	.706	.118	.177
Overall rating	.276	.291	.433

Inconsistency ratio = 0.000

decision problem.

Step 3. Based on the relational data developed in step two, two methods are used to assign relative weights to the criteria and relative ratings to the alternatives. According to Saaty, a "proportional method" is used for quantitative data, such as for the cost criterion, and an "*eigenvalue* method" is appropriate for qualitative data generated by the pairwise comparisons.

In the proportional method, relative weights are assigned according to the amount that each alternative contributes to the sum of the values of all of the alternatives for a particular criterion. Because less cost is preferred to more cost, Alternative C received the highest rating under the cost criterion. In the *eigenvalue* method, an eigenvector is estimated from a matrix of the pairwise comparisons to calculate the relative ratings for each alternative. A detailed description of this method is available elsewhere [17,18,19,20]. For either method, the relative weights or ratings are normalized to add to unity.

Table 3 shows the resulting vector of relative weights assigned to the three criteria and the matrix of relative ratings assigned to the alternatives based on these methods. The cost criterion was judged to be the most important to the taxiway decision, with a weighting of .648. The weight and congestion criteria have relative weights of .230 and .122, respectively. For the congestion criterion, Alternative A had the highest rating of .706; for the weight and cost criteria, Alternative C had the highest ratings.

Step 4. In the final step, the relative weights and ratings are combined into a single vector, reflecting the overall ratings of the alternatives. The vector of ratings for the alternatives is determined by a series of matrix multiplications beginning at the second level and ending at the lowest level of the hierarchy. In the taxiway example, the ratings of the alternatives were calculated by multiplying the vector of criteria weights against the matrix of relative ratings to yield an overall rating of .276 for Alternative A, .291 for Alternative B, and .433 for Alternative C. Accordingly, Alternative C is the preferred alternative.

IMPLEMENTATION ISSUES

Having reviewed the basics of AHP, a brief consideration of issues involving the use of AHP in an economic analysis is appropriate. The following listing is not comprehensive, but is intended to highlight issues and direct the reader to the relevant literature.

1. The *eigenvalue* method for establishing relative weights is computationally difficult. Without a familiarity with matrix algebra, the method is incomprehensible. Fortunately, the computations are made transparent by AHP software such as *Expert Choice* [9], or *Automan* [16]. Once the hierarchy is established, the software will systematically lead the decision maker through the necessary pairwise comparisons to establish the weights and ratings. After each set of comparisons is completed, the software will also provide information regarding the consistency of the judgments by reporting the inconsistency ratio, and prompt the user to redo the judgments as appropriate. Once accomplished, the software will compute the ratings.

2. The ratio scale used in AHP has been criticized as inappropriate. Saaty [20] argues that the intensity of preferences between alternatives can be expressed using a ratio scale; others disagree, claiming that an interval scale is appropriate. Harker and

Vargas [11] review this issue and rebut the criticism.

3. Saaty [20] has warned against combining costs with benefits in one hierarchy, and recommended separate hierarchies for each. The resulting ratings are then combined as benefit-cost ratios to establish a ranking suitable for selecting projects. Even if this is done, there are problems with the use of benefit-cost ratios derived from AHP to select capital investment projects [5,6]. Generally, the problem is using benefit-cost ratios for selecting projects, and not the method of establishing the ratios. The capital budgeting literature thoroughly addresses this more general problem [4].

4. A problem of "rank reversal" has been reported [3,27]. Rank reversal occurs when new alternatives are added to the hierarchy and the resulting new ranking differs from the former ranking. If the new alternatives provide no additional information on the relative rating of existing alternatives, then reversal should not happen. Harker and Vargas [11] rebut these criticisms as an inappropriate use of AHP, and suggest a method to avoid rank reversals. Schoner and Wedley also explored the issue and concluded that "*Those who were troubled by rank reversals when no real new information is added should be reassured that AHP can be made to work correctly*" [21:474].

5. It's unclear how multiple decision makers or evaluators can use AHP. Vargas and Saaty [25] have reported a few cases. Graham [10] has reported the use of AHP in an Air Force setting, where analysts perform the initial analysis, and provide it to a supervisor for consideration and possible revision.

6. In a typical economic analysis conducted in the Department of Defense, there are often significant pressures to force the analysis to favor a particular alternative. Thus, a third-party review is required to identify potential bias. It's clear that AHP can also be manipulated to favor a project. AHP software can facilitate the review by thoroughly documenting the decision problem and the judgments made to establish the ratings. In addition, AHP software can record these details for later sensitivity analysis.

CONCLUSION

Despite these technical issues, AHP has been applied to capital acquisition problems [1,10,12,13,16,25,26], and is consistent with the goals of economic analysis.

> *Economic analysis is an aid to rational choice among competing alternatives. It is not intended to replace the judgment of the decision maker but rather to aid that judgment. . . . a good economic analysis systematically examines and relates cost, benefits, and risks of various alternatives* [8:3].

AHP facilitates a comprehensive and rational analysis of the capital acquisition problem. Although the pairwise comparisons required in AHP may seem tedious, the method is systematic and comprehensive. All relevant comparisons are made. When the comparisons are illogical, the method warns the decision maker with the inconsistency ratio.

User friendly AHP software will lead the evaluator through all the pairwise comparisons, and compute the relative ratings and inconsistency ratios. The sofware will not, however, force the user into revising the judgments. AHP is a decision support tool; it does not replace the

decision maker.

Other important requirements of economic analysis are sensitivity analysis and thorough documentation to support subsequent third-party review. AHP software allows the decision maker to evaluate the sensitivity of the ranked alternatives to the weights assigned to the criteria and alternatives. Of course, weights can be easily changed and the impact of the change on the ratings is immediately apparent. In addition, the framework of the hierarchy and the weights are recorded for subsequent review. It's a relatively easy matter for a third party to use AHP software to evaluate the reasonableness another's judgments.

In short, AHP is a promising tool for facilitating an economic anlysis. Despite implementation issues and occasional technical objections, AHP has received wide application in multi-criteria problems. Given the increasing availability of personal computers and excellent AHP software, such as *Expert Choice* [9], the use of AHP in the capital acquisition problem is appropriate and highly recommended.

REFERENCES

1. Arbel, Ami and Abraham Seidmann. "Performance Evaluation of Flexible Manufacturing Systems. *IEEE Transactions on Systems, Man, and Cybernetics* 14 (July-August 1984): 606-617.

2. Battin, Jeffrey L. and Thomas J. Bender. *A Methodology For Project Selection Using Economic Analysis And The Analytic Hierarchy Process*. Master's Thesis. Air Force Institute of Technology (September 1992).

3. Belton, V. and T. Gear. "On a Short-coming of Saaty's Method of Analytic Hierarchies." *Omega* 11 (1984): 228-230.

4. Bernhard, Richard H. "A Comprehensive Comparison and Critique of Discounting Indices Proposed In Capital Investment Evaluation. *The Engineering Economist* 16 (Spring 1971): 157-186.

5. _____ and John R. Canada. "Some Problems in Using Benefit/Cost Ratios with the Analytic Hierarchy Process." *The Engineering Economist* 36 (Fall 1990): 56-65.

6. Boucher, Thomas O. and Elin L. MacStravic. "Multiattribute Evaluation within a Present Value Framework and its Relation to the Analytic Hierarchy Process." *The Engineering Economist* 37 (Fall 1991): 1-32.

7. Department of Defense. *Economic Analysis and Program Evaluation for Resource Management.* Department of Defense instruction 7041.3, October 18, 1972.

8. Department of the Air Force. Cost Analysis: *Economic Analysis and Program Evaluation for Resource Management.* Air Force Regulation 173-15. Washington: Headquarters United Stated Air Force, 4 March 1988.

9. Forman, Ernest H., Thomas L. Saaty, Mary Ann Selly, and Rozann Waldron. *Expert Choice*. McLean, VA: Decision Support Software, Inc., 1983.

10. Graham, David R. and Ernest Forman. "Cost Project Funding Choices Using the AHP & Linear Programming." Unpublished Report. Air Force Materiel Command Space and Missile Systems Center, Los Angeles AFB CA, 1992.

11. Harker, Patrick T. and Luis G. Vargas. "The Theory of Ratio Scale Estimation: Saaty's Analytic Hierarchy Process," *Management Science 33* (November 1987): 1383-1403.

12. Jensen, R.E. "A Dynamic Analytic Hierarchy Process Analysis of Capital Budgeting Under Stochastic Inflation Rates, Risk Premiums, and Liquidity Preferences: Theory." *Advances in Financial Planning and Forecasting* 2 (1987): 269-302.

13. _____. "International Investment Risk Analysis: Extensions for Multinational Corporation Capital Budgeting Models." *Mathematical Modelling* 9 (1987): 265-284.

14. Kaplan, Robert S. "Must CIM Be Justified By Faith Alone?" *Harvard Business Review* 64 (Mar-Apr 1986): 87-95.

15. Pinches, George E. "Myopia, Capital Budgeting and Decision Making." *Financial Management* 11 (Autumn 1982): 6-19

16. Romano, Patrick L. "Automan-Decision Support Software." *Management Accounting* (November 1989): 58-60.

17. Saaty, Thomas L. *The Analytic Hierarchy Process*. New York: McGraw-Hill Book Company, 1980.

18. -----. *Decision Making For Leaders*. Belmont CA: Lifetime Learning Publications, 1982.

19. _____. "Decision Making, Scaling, and Number Crunching." *Decision Sciences* 20 (1989): 404-409.

20. _____. "How to Make a Decision: The Analytic Hierarchy Process." *European Journal of Operational Research* 48, (1990): 9-26.

21. Schoner, Bertram and William C. Wedley. "Ambiguous Criteria Weights in AHP: Consequences and Solutions." *Decision Sciences* 20 (Summer 1989): 462-475.

22. Stout, David E. and others. "Decision Support Software for Capital Budgeting: It Can Help Quantify Intangible Benefits of Capital Investments." *Newsletter of the Society of Cost Estimating & Analysis* (October 1991): 4-8.

23. Vargas, Louis G. "Reciprocal Matrices With Random Coefficients." *Mathematical Modelling* 3 (1982): 69-81.

24. _____. "An Overview of the Analytic Hierarchy Process and its Applications." *European Journal of Operational Research* 48 (1990): 2-8.

25. _____ and Thomas L. Saaty. "Financial and Intangible Factors in Fleet Lease or Buy Decisions." *Industrial Marketing Management* 10 (1981): 1-10.

26. Varney, Mark S., William G. Sullivan, and Jeffrey K. Cochran. "Justification of Flexible Manufacturing Systems With The Analytic Hierarchy Process." *Proceedings of the 1985 International Industrial Engineering Conference*. Norcross, Georgia, Institute of Industrial Engineers, 1985.

27. Watson, S.R. and A. Freeling. "Assessing Attribute Weights By Ratios." *Omega* 10 (1982): 582-583.

28. Zahedi, Fatemeh. "The Analytic Hierarchy Process -- A Survey of the Method and its Applications." *Interfaces, 16* (February 1986): [illegible]-108.

INNOVATIONS IN SUPPORT SERVICE CONTRACTOR AWARD FEE PERFORMANCE EVALUATION PROCESS

Cinda Chullen, National Aeronautics and Space Administration
and
Arthur W. Authier and Donna E. Quintela
Lockheed Engineering & Sciences Company

ABSTRACT

The National Aeronautics and Space Administration (NASA) uses the Cost Plus Award Fee (CPAF) type contract extensively to meet program goals associated with its high technology research and development environment. Under the CPAF type contract, the contractor earns fee based on periodic NASA performance evaluations. Recently the agency has sought to improve the timeliness and reduce the complexity of this award fee performance evaluation process.

On a major support services contract at the Lyndon B. Johnson Space Center (JSC), substantial improvements have been implemented to reduce the effort and paperwork involved in the process and also decrease the time it takes to inform the contractor of the fee determination award.

The improvements discussed in this paper involve: (1) consolidating many similar small job orders into larger ones for more effective control and cost avoidance; (2) elevating the lowest level of evaluation to the division level while retaining job order evaluation as a local option; (3) training NASA personnel in performance evaluation – this training included both the publication of the *Engineering Support Contract (ESC) Management Guide*, which documents this process, and the addition of an award fee module in an existing training course; and (4) inviting the contractor to make an oral presentation of its self-evaluation.

These innovations, which strongly support NASA's commitment to the continuous improvement aspect of total quality management (TQM), are presently under consideration as a candidate for best practices in technical contract management to be shared with other NASA centers.

INTRODUCTION

NASA is heavily involved in the planning, development, and operations of several programs supporting our National space effort. These include the Space Shuttle, Space Station, and Advanced Programs. The resources necessary to support these programs come from diverse combinations of civil service and contractor organizations. Primary contractor support for these programs comes from major prime contractors who are involved in hardware development. However, NASA augments its technical skills through service type contracts providing support in the areas of engineering and science analysis, testing, simulation, and integration, as well as facility operation and maintenance.

JSC, in particular, has found that these augmented technical skills have been provided effectively under a CPAF type contract. One such CPAF type contract at JSC is the Engineering Support Contract (ESC). The ESC is a high-technology, level-of-effort contract involving some 2,200 Lockheed Engineering & Sciences Company (LESC) personnel who provide services to

twenty different JSC Divisions and Offices. These JSC organizations have major responsibilities in ongoing efforts for the Space Shuttle, Space Station, and Advanced Programs.

Under CPAF provisions, the contractor is awarded a fee based on technical, management, and cost performance. Recently this process has come under the scrutiny of senior NASA management for its complexity and its failure to be conducted in a timely manner.

Darleen A. Druyun, former NASA Associate Administrator for Procurement, commented on this problem in an October 1992 "CM Interview" article in *Contract Management*, the National Contract Management Association (NCMA) periodical. Ms. Druyun was responsible for leading a number of initiatives to streamline the NASA procurement process. One of her first initiatives was to improve relations between the contractors and NASA. Contractors had expressed frustration in dealing with NASA on contractual matters. "About 76 percent of NASA's contracts are CPAF," stated Ms. Druyun, "so it was almost a safe bet that one of industry's chief complaints would come in the area of CPAF contracting." She also mentioned that many contractors had told her that "some of the agency centers" had been taking "up to 4 months to process payment after the board met."

While NASA management was reviewing its award fee contracting process, parallel efforts to improve this process were being implemented at JSC on the ESC.

THE ENGINEERING SUPPORT CONTRACT

The ESC requires periodic evaluation of contractor performance. Fee dollars are awarded to the existing contractor, LESC, based on its performance. The ESC Award Fee Plan provides a structure whereby LESC is evaluated on a quarterly basis and fee is awarded on a semiannual basis.

Work is authorized on the ESC through the use of fiscal year job orders issued by JSC Divisions or Offices. This level of work is the basis of cost and technical progress reporting. Summary level report rollups follow an organizational breakdown structure (OBS). Figure 1 depicts the relationship between the functional work unit structure and the OBS.

Previous performance evaluations were made at the job order level and then summarized to the Division level; thence to the Directorate level; and thence to an ESC level, where the fee determination was made. The large number of small job orders made this process very time consuming and inefficient. As a direct result of the vast amount of time and paperwork inherent in the process, the fee determination to LESC was taking over 3 months.

A research effort was initiated to determine methods to improve this process. Care was taken not to degrade the Government's need for a performance evaluation tool. Likewise, a timely contractor performance feedback mechanism needed to be preserved that facilitated corrective action prior to the next evaluation period.

FACT FINDING

A review of the ESC Award Fee Plan and the applicable JSC Management Directive was conducted to determine the real requirements. The requirements in the contract were (1) the contractor had to be evaluated quarterly by a Performance Evaluation Committee (PEC); (2) a Performance Evaluation Board (PEB) had to review a 6-month evaluation report submitted by the PEC; (3) the PEB submitted its

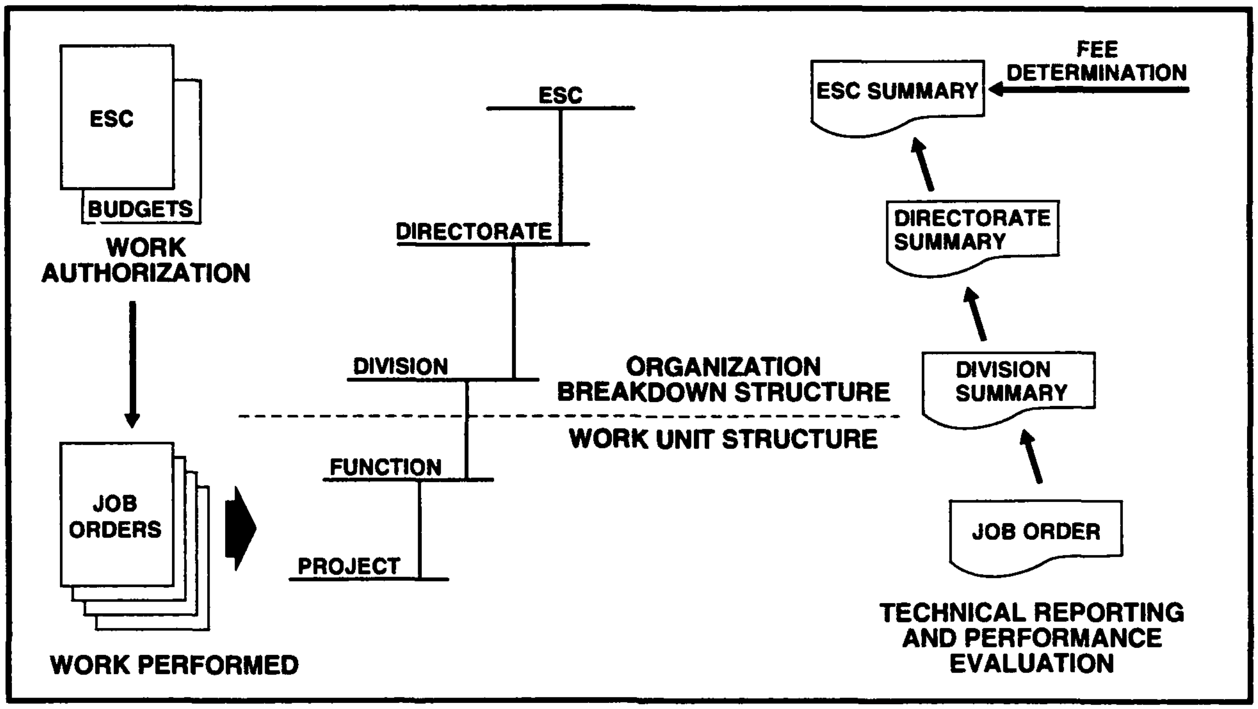


Figure 1.- ESC functional work unit structure / organizational breakdown structure configuration.

evaluation to a Performance Determination Official (PDO), a senior NASA official; and (4) the PDO made the award fee determination. The PDO also had to give consideration to information submitted by the contractor within 15 days after the award fee period ended.

In addition to what was in the contract, further requirements were contained in a JSC Management Directive, "Performance Evaluation and Notification Procedures for Award Fee Contracts," issued November 23, 1988, by JSC Director Aaron Cohen. The Directive states that the PEC is required to have its evaluation information to the PEB secretary no later than 30 days after the evaluation period ends. The PEC secretary has 15 days following the 30 to resolve any corrections to the evaluation information with the PEC chairperson. And finally, the PEB is required to have scheduled and reviewed the evaluation information submitted by the PEC within 15 days after the PEB secretary has reviewed the information.

During the research, a process flow of the performance evaluation was prepared. The flow revealed a substantial amount of lower level backup (paper) was being generated to support the PEC's contract level recommendation to the PEB. Figure 2 depicts the performance evaluation process, identifying areas that were eliminated.

A time line was also constructed that depicted the actual time from the end of the performance evaluation period to actual fee determination. The six periods measured averaged 70 days, with the highest being 99 days. Figure 3 depicts historical processing for those evaluations.

JOB ORDER CONSOLIDATION

While the performance evaluation process was being reviewed, a TQM effort

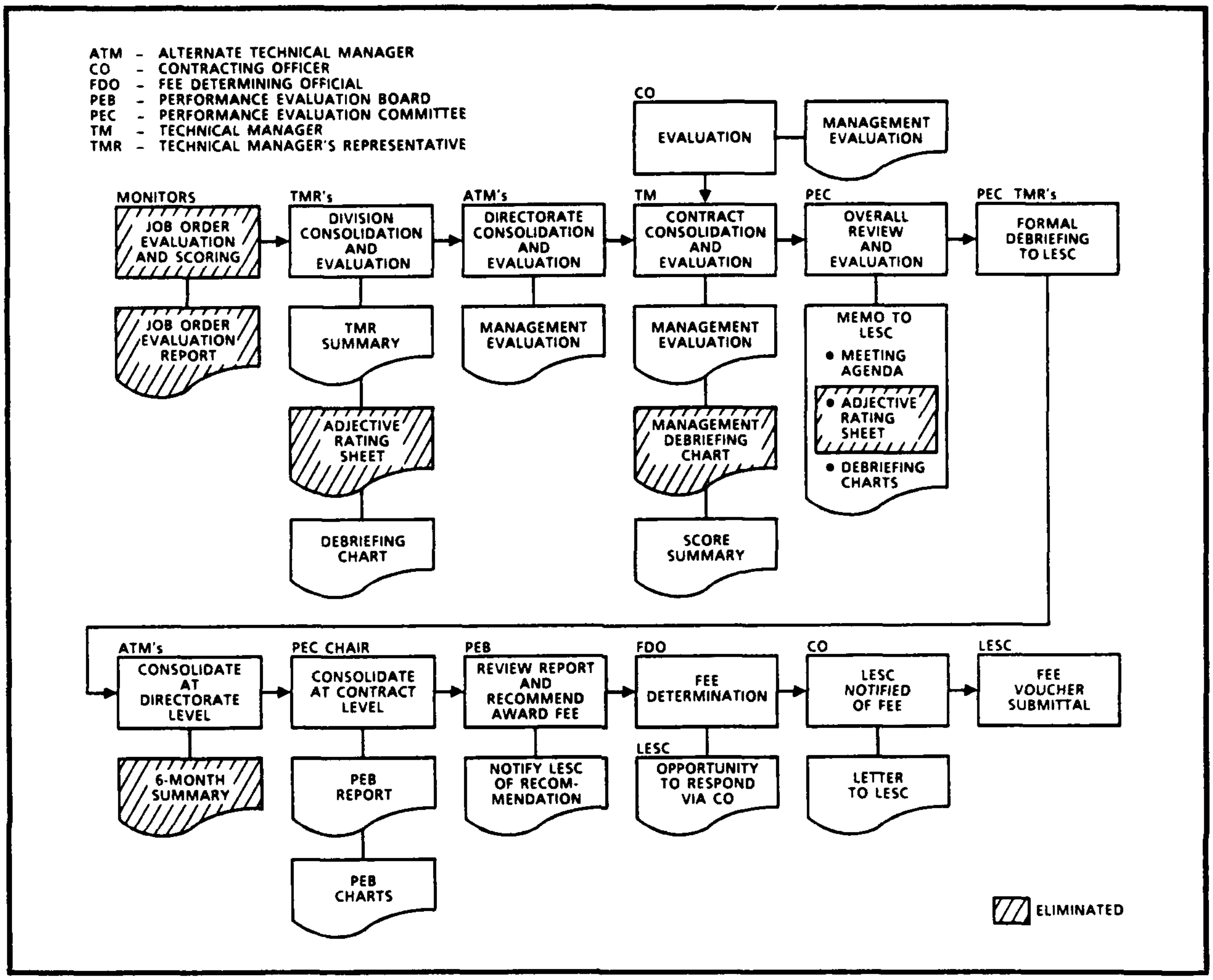


Figure 2.- ESC performance evaluation process flow.

was also in process to reduce the excessive number of job orders – in particular, the small duplicate ones.

Over the past several years as funds became more limited, the need arose to plan and track line items at smaller values. Job orders were written to match these smaller funding amounts. Quite often these small job orders were functionally redundant. As many as 813 job orders were in effect for fiscal year 1990 on the ESC. This was 2.5 equivalent persons per job order that year alone.

Discussions were held with the entire ESC management team. Technical, business, and contract managers from NASA were involved, as well as contractor management representatives. The result of this team effort, achieved for fiscal year 1991, was a reduction from 813 to 500 job orders. The savings due to the reduction in paperwork, data processing, reporting, and performance evaluation effort were obvious. An even better improvement was realized in fiscal year 1992, when the number of job orders was reduced to 165 with the implementation of another TQM initiative – the Simplified Project Control System. The number of equivalent persons per job order increased to 12.3 in this year.

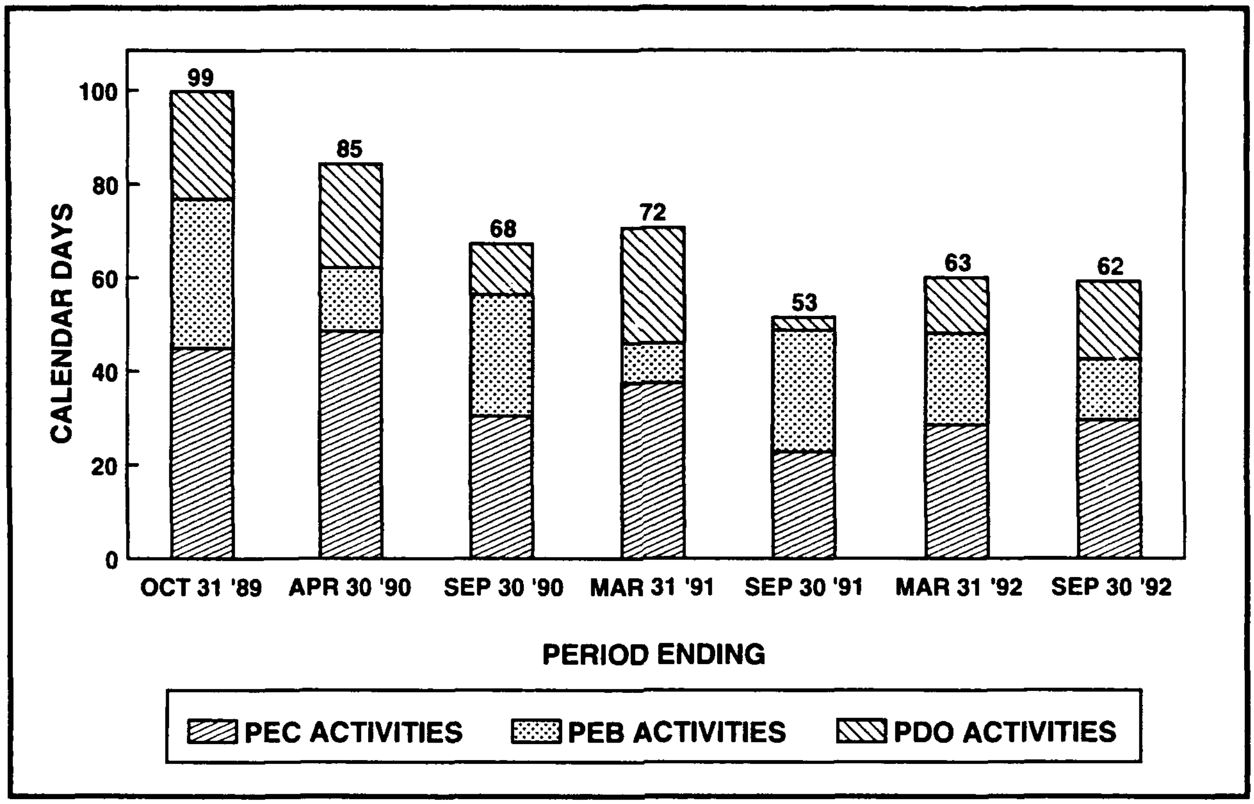


Figure 3.- ESC performance evaluation process cycle time history.

PROCESS IMPROVEMENT

An analysis of the ESC Performance Evaluation Process Flow revealed that any significant reduction to the process would have to be made at the lowest level where some 250 NASA job order monitors evaluated some 500 job orders. No changes could be made to the organization structure where the summary rollups occurred.

The NASA Technical Manager proposed raising the lowest level of the evaluation that would be delivered to the PEC to an overall evaluation at the Division level, thus removing the formal requirement to deliver an evaluation by job order to the PEC. However, each Division/Office would retain discretion regarding the internal procedures used to arrive at the Division level evaluation. This suggestion was briefed to the Division/Office level managers. The change was overwhelmingly accepted and implemented for the evaluation period in progress at the time.

The savings at the Division level, with no degradation to the process, were immediate. Two Division Chiefs wrote letters of commendation to the NASA Technical Manager for taking the initiative to delete the need for unnecessary requirements.

In concert with raising the lowest level of evaluation, all of the steps in the process were put to the acid test and examined for "value added" contributions. This resulted in the elimination of adjective rating sheets and the reduction in the size of the presentation package used to brief both the PEC and the PEB.

Other process improvements involved realignment of certain activities to enhance the effectiveness and efficiency of the performance evaluation process. For instance, the original

contract specified performance evaluation periods in 6-month intervals from the start date of the contract. This resulted in evaluation periods that did not coincide with the normal Government fiscal year operating cycle on which the contract is conducted. Realignment of the evaluation periods to coincide with the Government fiscal year allowed the utilization of information routinely reported instead of information which had to be reformatted to fit the unique evaluation periods. Additionally, original contract provisions were modified to revise the requirements for the contractor's Quarterly Progress Report. The reporting level, which was originally at the job order level, was elevated to the Division level to coincide with the level at which the evaluation was now performed. The size of the report and the management preparation time both decreased significantly, and the accelerated delivery schedule allowed the information to get to the NASA Divisions in time to be utilized during the contractor performance evaluation.

The new process has been used three times with no complaints from the contractor or NASA evaluators. The new process has also reduced the time usually required to debrief the contractor. The technical level of detail to require corrective action is still retained.

NASA TRAINING

In addition to the large volume of NASA technical management personnel involved in the evaluation process, a large turnover of these personnel was being experienced that added to the training challenge.

A course had been developed by the contractor, and paid for by NASA, entitled *The Job Order/Project Control System*. Initially geared for contractor personnel, the course was modified for NASA attendance, and an Award Fee Process module was added to the curriculum. This new module was instructed by the NASA Technical Manager. However, because this training course was considered familiarization training on a volunteer basis, not everyone attended. Based on low attendance by NASA personnel, another method was needed to reach all the players.

The NASA Technical Manager created the idea for the *ESC Management Guide*, which, among other things, documents the evaluation process. Evaluation forms are included, as well as the purpose and composition of the committee and the board. The *ESC Management Guide* is widely distributed and is revised and distributed usually at the beginning of each fiscal year or as needed.

CONTRACTOR PRESENTATION OF SELF-EVALUATION

The ESC Award Fee Plan provides the contractor with the opportunity to submit a self-evaluation at the conclusion of an evaluation period. Traditionally, this self-evaluation was submitted in written format, addressing cost performance and, more recently, management and productivity. Since the self-evaluation was in written format only, it provided no formal mechanism for NASA-contractor interaction in regard to what was submitted. An occasional telephone call about a line item was not an adequate interchange. The NASA PEC chairperson offered LESC's program manager the opportunity to present the contractor self-evaluation in the form of a briefing. This briefing has been in existence for the last two 6-month evaluation periods, with PEC members attending on a voluntary basis. Because it has effectively fostered verbal interchange on major issues, it has proven to be quite beneficial, in achieving a better

understanding of both the performance and the operational drivers.

WHAT NEXT?

Although significant progress in improving the award fee evaluation process has been achieved on the ESC, NASA and JSC have been slower, on the average, in providing feedback and paying fee on CPAF type contracts. Data submitted to NASA Headquarters in October 1992 indicated that JSC averaged 118 calendar days from the end of the evaluation period until the payment of the award fee to the contractor. The 118 days consisted of 92 days for fee determination and an additional 26 days for payment of the award fee. In a letter dated December 30, 1992, from the NASA Administrator to the Directors of the field installations, Daniel S. Goldin indicated he was "disappointed to see the length of time it takes NASA to provide a final evaluation of performance to contractors after the end of the period, and then to pay them the actual fee awarded." In the same letter, Goldin established an objective of 45 calendar days from the end of the evaluation period to the issuance of the final fee determination and 15 calendar days from the fee determination to the payment of fee, for a total of 60 days to complete the entire process.

In response to Goldin's objective, JSC Acting Director Paul J. Weitz has recently set more specific objectives to help achieve the 60-day goal by March 31, 1993. One of the more critical objectives involves shortening the process times of PEC and PEB activities. The PEC activities will have to be completed within 20 calendar days from the end of the evaluation period and the PEB activities within an additional 10 days. The fee determination will then have to be made within 15 days of the PEB recommendation and the payment of award fee not later than 15 days thereafter. Under these objectives, the entire process would be completed within 60 calendar days after the end of the evaluation period.

Although the average time for performance determination and award fee payment on the ESC has been reduced to 70 days (versus the JSC average of 118 days cited earlier), further improvements will be necessary to achieve the 60-day objective. Emphasis will be placed on documenting performance drivers throughout the evaluation period so that formalization and submittal of the documentation at the end of the period will be a relatively short, simple task and will allow the PEC activities to be completed earlier. Additionally, PEB activities could be shortened by prescheduling the PEB meeting and eliminating or rephasing the PEB Secretary's review of the PEC's report to the PEB, which currently occurs prior to the PEB meeting. Finally, successfully implementing the new 15-day objective for PDO activities should ensure that the entire process is completed on a more timely basis.

SUMMARY

The techniques which have been and will be used to improve the ESC Award Fee Performance Evaluation Process are fairly straightforward and probably apply to other managerial practices. The following steps are presented for reader consideration:

1. Determine what the "real" requirements are, and create a work flow for that process. It's difficult to improve a process before it's documented.

2. Perform a "value added" test against each activity. Eliminate rubber stamp and unnecessary activities.

3. Don't be afraid to take risks to eliminate paper, raise approval levels, and get to the heart of absolute requirements.

4. Empower people to make and implement change.

ABOUT THE AUTHORS

Cinda Chullen is the Technical Manager of the Engineering Support Contract at the Lyndon B. Johnson Space Center in Houston, Texas. Arthur W. Authier is the Project Manager, and Donna E. Quintela is a planner in the Program Planning and Analysis Office, Lockheed Engineering & Sciences Company, Houston, Texas. All are members of the Space City Houston Chapter of the NCMA and have authored an article for the May 1992 issue of *Contract Management.*

MODELING AND SIMULATION FOR SOURCE SELECTION BOARDS

Mr. Dennis M. Clark II, SPAWAR 42

Abstract

This research effort details a modeling and simulation effort which supported the evaluation of proposals for a Fiber Optic Data Bus. The intent was to model each contractor's proposal and compare the various proposals' technical performance. The effort would allow an objective comparison – based on quantifiable data – of the proposals to augment the judgment of the Technical Evaluation Team. This research describes the results of these efforts and lessons learned in relation to utilizing these modeling and simulation techniques for source selection of this nature.

Task Description

The Center for Advanced Concepts Development (CACD) was asked to participate in the Fiber Optic Data Bus (FODB) proposal evaluation by providing modeling support to the Technical Evaluation Team (TET). The intent was to model each contractor's proposal and compare the various proposals' technical performance. It was hoped that this effort would allow an objective comparison – based on quantifiable data – of the proposals to augment the expert judgment of the TET.

The Request For Proposal (RFP) announced that each proposal would be modeled by the government in the OPNET™ simulation environment. Furthermore, each contractor was required to complete a detailed Data Information Form in the RFP and include it with their proposals.

Proposal offerors were required to submit bus architectures that operated in two distinct throughput ranges. A Low-End architecture was to address throughput requirements in the 100Mb/sec - 800Mb/sec range. The High-End architecture was to address throughput requirements in the 800Mb/sec - 1.2Gb/sec range

Figure 1 illustrates the procedure developed for the modeling effort. CACD involvement began several months before the RFP was issued. CACD personnel reviewed the RFP, recommended many changes, developed the Data Information Form, and assisted with the development of the Measures of Effectiveness (MOEs) for the modeling effort. To expedite model development, in what was anticipated to be a limited amount of time, the most likely architectures (star, FDDI, and Token Ring) were identified and "skeleton" models were developed prior to the delivery of the RFP responses. The intent was to flesh out the skeletons with details provided by contractor Data Information Forms and complete the modeling effort rapidly during the evaluation phase.

The strategy then, was to complete skeleton models with details provided by the offerors, run the models with varying data rates and packet sizes, and compare the data throughputs. Data throughput measured against varying data rates and packet sizes was the adopted MOE.

Procedure

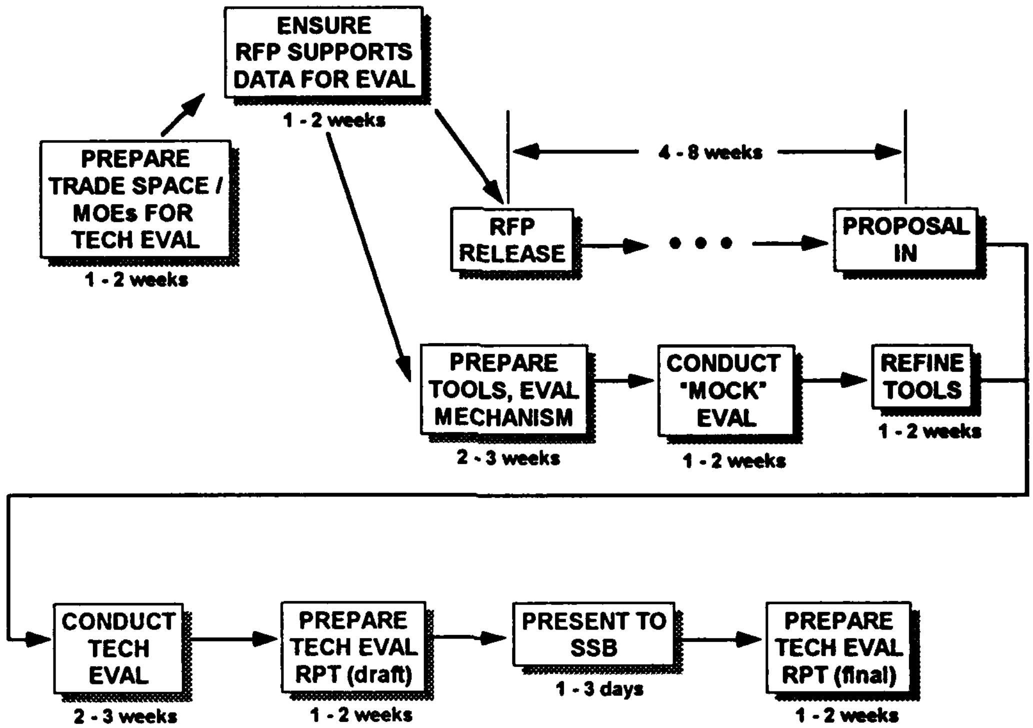


Figure 1

Proposal	Architecture	Modeling Effort
#1 LOW-END	Star	Model Developed
#1 HIGH-END	MUX	None - Protocol Independent
#2 LOW-END	Ring	None - Insufficient Data
#2 HIGH-END	Ring	None - Insufficient Data
#3 LOW-END	Star	Model Developed
#3 HIGH-END$_1$	Star	Model Developed
#3 HIGH-END$_2$	MUX	None - Protocol Independent
#4 HIGH-END	Star	None - Insufficient Data
#4 LOW-END	Star	None - Insufficient Data
#5 LOW-END	Ring	Model Provided
#5 HIGH-END	Ring	Model Provided

Table 1

A month before the actual evaluation, a "mock" evaluation was conducted to identify problems, correct them, and refine the tools and procedures necessary to complete the modeling effort. The mock evaluation was successful; however, members of the TET announced that only two weeks could be allowed for the modeling effort vice the four to six weeks shown in figure 1. At the time, this reduction in time was not of concern since only a limited number of proposals was anticipated.

Modeling: Summary and Discussion

Summary

Table 1 summarizes both the proposals and modeling effort. Figures 2-4, which follow, show the technical performance of the proposals which were modeled.

Discussion

There were a total of five responses to the RFP. Included in these five responses were eleven proposals. In the interest of anonymity, the proposals are hereafter referred to by number.

Proposal #1 Low-End

The proposed architecture for this design was a star configuration with a maximum of 32 nodes. The protocol, also known as the High Speed Data Bus (HSDB), is based on the linear token passing bus. This variant employs a central controller. The controller uniformly distributes tokens to the Bus Interface Units (BIUs).

The proposal claimed a bandwidth of 200 MB/sec which the model verified. This bandwidth was achieved with a saturated bus whose saturation rate was calculated to be 760 packets/sec/node for 32 nodes. The throughput for the remaining packet sizes was consistent with the 4b/5b encoding scheme.

Further analysis with varying packet sizes and data rates revealed that this design was technically capable of supporting the low end data rates.

Proposal #1 High-End

The proposed architecture for this design was a high-speed multiplexer. Since the approach's protocol demonstrated no perturbations as data rates varied and the thrust of the modeling strategy was to measure these perturbations, this proposal and others with similar architectures was not modeled.

Proposal #2 Low-End

There were several difficulties involved with attempting to construct a model with this proposal. It combined a Synchronous Optical NETwork (SONET) protocol with an FDDI-1 overlay. In this scheme, the FDDI overlay functioned as the Asynchronous Transfer Mode (ATM) layer. While the CACD modeling library contains an FDDI model, it does not contain a SONET model. The addition of a SONET model of sufficient fidelity proved to be outside the time constraints of this project. This proposal was one of several proposals that made use of the SONET protocol. The appearance of this protocol was surprising to the CACD and the TET. SONET had not been among those architectures and protocols that were identified and modeled

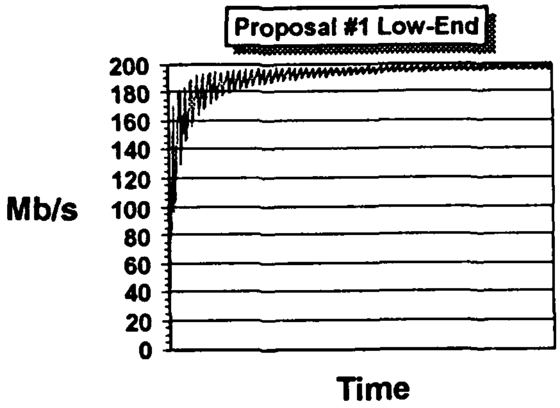


Figure 2

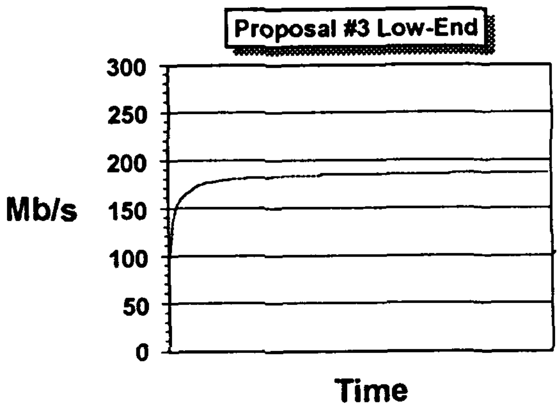


Figure 3

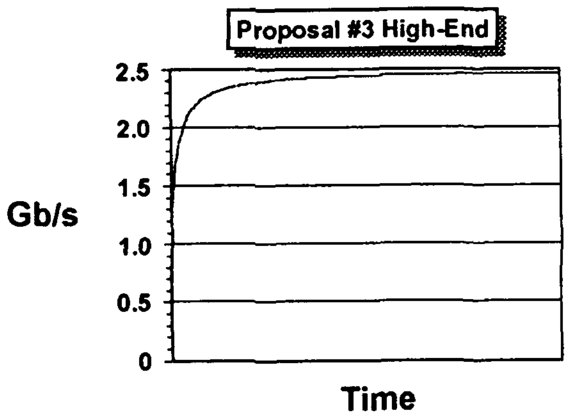


Figure 4

---

*All output represents a word size of 256 words (@ 32 bits/word)

during the preparatory phase. To add to the difficulty, the proposal failed to adequately explain the integration of the SONET and FDDI protocols. Combined, these difficulties prevented modeling this proposal.

Proposal #2 High-End

This proposal combined a SONET protocol with a ring topology. The proposal, like its low-end partner, failed to adequately describe its implementation of SONET. That failure, in addition to the CACD's lack of experience with the SONET protocol, also removed this proposal from modeling consideration.

Proposal #3 Low-End

The proposed architecture for this design was a star configuration with a maximum of 32 nodes. Its protocol consisted of a proprietary token-passing scheme with a central controller which uniformly distributed tokens.

The proposal claimed a bandwidth of 300 Mb/sec; however, this claim could not be substantiated with the CACD's model. The model demonstrated a maximum throughput of 190 Mb/sec using a saturation rate of 1144 packets/sec/node for 32 nodes. Throughput for the remaining packet sizes was consistent with the demonstrated maximum rate and the 4b/5b encoding scheme.

This design consistently fell short of its bandwidth claims during testing. The model was run using a range of packet sizes and data rates. Its bandwidth was consistent with a single-stream transmit rate with encoding.

Proposal #3 High-End$_1$ (Two Designs)

The proposed architecture for this design was a star architecture with a maximum of 32 nodes. Its protocol was a polling scheme which distributed SONET frames. Since the proposal fully described its implementation of SONET – particularly its use of SONET frames – the proposal was easily modeled.

The proposal claimed a bandwidth of 2.488 GB/sec, the maximum SONET bandwidth. CACD's model verified this claim over a range of packet sizes. Bandwidth was calculated using a saturation rate of 250 packets/sec/node for 32 nodes. Since there was no encoding scheme used, the throughput for the various packet sizes was consistent with the maximum rate.

Additional model runs using a range of packet sizes and data rates demonstrated that the design can support all high-end throughput requirements.

Proposal #3 High-End$_2$

Another multiplexing scheme. As stated earlier for Proposal #1 High-End, a multiplexing architecture shows no perturbations as data rates are varied; therefore, this proposal was not modeled.

Proposal #4 Low-End

This proposal used a ring architecture with a Time-Division Demand Assignment protocol. Unfortunately, the Data Information Form and the text of the proposal were extremely confusing. We encountered several problems because of inconsistencies between the text and illustrations and with inadequate descriptions of the frame formats. After

struggling to understand the proposal, we enlisted the help of the TET's communication engineering staff. They were equally confused by the proposal's descriptions. The inability of this proposal to clearly define its protocol removed it from modeling consideration.

Proposal #4 High-End

This proposal closely paralleled its Low-End partner. It was equally confusing and was likewise removed from modeling consideration.

Proposal #5 Low-End/High-End

This proposal used a unique design which was scalable across both the low- and high-end throughput rates. The network topology consisted of a ring with a rotating data frame. The protocol incorporated a large frame (1800 bits) with assigned slots for each BIU. The frame rotated around the ring from station to station. As the frame arrived at each station the local BIU wrote information in its assigned slot. Thirty-two ring stations were used.

The throughput rates for this architecture were dependent on the rate at which the frame rotated around the ring and not on the rate at which the BIUs generated packets. In this respect it was similar to the high-end MUX submissions in proposals #1 and #3.

A complete OPNET™ model was included as part of the required Data Sheet. Also included were examples of expected output from the model runs. Unfortunately, after copying the included model and regenerating the output, the provided examples could not be duplicated. In those examples, the queues were filling up and emptying at a steady rate. The graphs generated by the CACD's model show that the queues were filling up at a rate greater than the rate at which they were being emptied. Although the modeled throughput was shown to be the same as that claimed, the behavior of the queues was of concern.

Benefits

The benefits of this unique approach to source selection were as follows:

(1) Verification of proposal performance claims.
(2) Quick identification of incomplete or immature designs.
(3) Lay the groundwork for future efforts.

Verification

Although the number of proposals that were completely modeled proved to be less than anticipated, those that were modeled provided new insight to verifying the claims made in the proposals. This project was sensitive to the performance of the selected design as indicated by the primary MOE (throughput). Therefore, any quantifiable comparison of designs was welcome. The intent was to provide an objective measurement of the performance of the designs. In this way not only could designs be matched against published claims, but they could be matched against each other to determine which designs were most efficient. This was a task that the modeling effort performed admirably. A definitive measure of the throughput of the modeled designs was provided to the Source Selection Board (SSB).

Of the three instances where this information was provided to the SSB, two of the proposal claims were upheld, but the third fell short. This apparent shortfall forced a closer look at the text of the proposal. Had the model not been constructed, this reexamination may have never occurred.

Acceptability

The modeling effort also revealed another problem that occurs when attempting to evaluate a proposal. During the attempt to make a model of a system that is described on paper, it is not rare to come across inconsistencies or omissions that may escape attention if one relies solely on the information in written form. This is even more likely to occur when a series of competing proposals is being evaluated.

During the course of the effort presented here such a scenario indeed happened. The definition of proposal #4 included many such inconsistencies, so many that this proposal was removed from consideration. The inability to construct a model of this proposal revealed an immature design that was quickly discarded and valuable time was not spent deciding whether or not this design was feasible.

Pioneering

Lastly, the lessons learned when attempting to do something for the first time are invaluable. The trials and tribulations of trailblazing often make the path much smoother for those that follow. Iteration spawns improvement.

Problems

Several problems prevented us from completely reaching the objective of the modeling support; a quantified technical comparison of all proposals, from being achieved. They were:

(1) Inadequate time for modeling.
(2) Incorrect assumptions during modeling preparation.
(3) Inconsistent completion of the Data Information Forms.

Time

By the time the proposal evaluation began, the time allocated to modeling had been reduced to seven days. It wasn't enough time.

To add to the problem the CACD anticipated modeling no more than 3-5 proposals of known architecture and protocol. Additionally, engineering support by TET members had been guaranteed. Because such a low level of effort was anticipated, with readily available engineering support, only one software engineer was allocated to the project. This level of support was insufficient.

When the proposals were delivered to the CACD, eleven proposals needed to be modeled. Unexpectedly, both new architectures and protocols had been introduced. In particular, the introduction of the SONET protocol in several proposals took everyone by surprise. The CACD was not prepared for the magnitude of effort required nor for the technical challenge in understanding and modeling a new protocol in so short a time. Adding to the problem was the inaccessibility of TET engineers to provide technical support. They were

located across town in a room with no telephone. Several hours were required to establish communication with them and then they were often busy responding to other time critical issues.

Assumptions

The program director, his staff, and the CACD anticipated two to three offerors with proposals which were well understood using architectures and protocols which had already been modeled. Some architectures were so well understood that the team believed that some proposals would not need to be modeled. Finally, the experience during the "mock" evaluation had confirmed the team's confidence in the adopted MOE.

All of these assumptions proved to be incorrect. First, there were five offerors with a total of eleven proposals. Both new architectures and protocols were introduced. No one in the CACD had any experience with the SONET protocol and the few experienced engineers proved to be inaccessible. Two of the proposals used architectures which invalidated the MOE thereby reducing the value of modeling. *(#1 HE, #3 HE)* One of the proposals proved that the selected MOE was not the only indicator of performance that should have been examined. *(#5)* Four of the designs were not clearly or completely defined enough to construct a model. *(#2 HE, #2 LE, #4 LE #4 HE)* Fortunately, two proposals were so clearly defined and described that the path from Data Information Form to inclusion in the CACD modeling environment was very clearly laid out. *(#3, #5)* (This was the intent of the Data Information Form.) This left three proposals which were completely modeled.

Data Information Form

Offerors were inconsistent in completing this form despite the RFP's announcement that each proposal would be modeled in OPNET™ and its requirement to submit a completed form as part of each proposal. Some offerors' forms reflected an appreciation of the OPNET™ tool and were so well completed that they allowed direct keying of the model. Others were so incomplete and contradictory that they confused both software and communications engineers. In hindsight, a correctly completed form should have been included in the RFP as an example and the importance of completing the form should have been more strongly emphasized.

Conclusion

The field of Modeling and Simulation has advanced significantly in the last few years. Its recent growth has enabled groups of all types to use it in new and interesting ways. One of those ways is the innovative use of simulations to evaluate bus alternatives during the proposal evaluation phase that the FODB team chose to use. This was the first time that a Source Selection Board was able to view the results of models based on the designs under their evaluation.

Several lessons were learned about the use of modeling and simulation for a project of this type and the ways in which it might be improved. The problems described above are examples of the lessons learned with this project. A few key items need to be changed to make the second time around a complete success. More time has to be allocated. Unfortunately, time is one thing that source selection boards may not enjoy. Given this constraint, more attention must

be focused on preparation and enforcement of the Data Information Forms.

Better preparation would not allow show-stoppers such as SONET to appear unexpectedly during the evaluation phase. Prior knowledge of complex protocols allow the bulk of the simulation work to be done before the evaluation phase and outside the demanding time constraints.

Enforcement of the Data Information Forms would eliminate the ambiguity and contradiction that was apparent in forms for this effort. A detailed example form must be included in the RFP and the RFP must clearly state that incorrectly completed or incomplete data forms will disqualify the proposal.

While the CACD's modeling support failed to provide a complete quantifiable comparison of all proposals, it did contribute to the elimination of some of the proposals. It also demonstrated the potential of modeling and simulation for future Source Selection Boards.

THE MANAGEMENT OF INFORMATION SYSTEMS IN THE FEDERAL GOVERNMENT

Patricia A. Connell
Assoc. Hd. Services & Support Division, Code C633
Naval Air Warfare Center Weapons Division, China Lake, California

ABSTRACT

The Federal government has a history of controlling new items of technology. Typewriters and facsimile machines were highly regulated when first introduced (and still are to some extent) into the government work force. The current technology under rigid control (although it is certainly not new anymore) is the computer system or information resource. Congress initiated control of this area of technology in 1965[1], by requiring the General Services Administration (GSA) to buy or delegate the authority to buy all of the computers for the Federal government. At that time, the perception of congress was that computers were very expensive toys and that the individual Federal agencies and their personnel could not be trusted to buy or manage them. The term computer is being used generically in this paper and represents every level from personal (desk top, single-user) to mainframe (multi-user). The perception that the user cannot be trusted is still widely held. This is evidenced by the regulations established by GSA[2] to control information resources. This is in addition to the layers of policy and regulation developed by each of the individual agencies and the services within each agency. In order to provide more productive and efficient management of these resources the redundant regulations and policies need to be reduced. In addition, management emphasis needs to be placed on the software applications, not the hardware platform.

INTRODUCTION

The technology of computers or information systems is highly dynamic. In the last five years alone, the technology advances in computing hardware have decreased the cost and footprint (amount of space taken up by the hardware platform) of computers dramatically while increasing the power and capability to the point where a desktop computer can now process the same information that a mainframe once did[3]. One example of this technological advancement is Digital Equipment Corporation's VAX 8600 mini computer. A VAX 8600 bought in 1986 at a cost of $250,000.00 is today being replaced by the VAXStation 3000 or 4000 series desktop workstations at a cost of between $25,000.00 and $50,000.00 (depending on the capability and peripherals). Today's VAXStations have a computer power sixteen times greater than the 1986 vintage VAX 8600[4]. Software costs associated with this particular manufacturer's computers is comparative to the hardware cost. This means that the associated purchase cost for the software operating system and applications has decreased. In those cases when one computer system is traded up for another newer technology computer, the software would just be transferred from one machine to another. The only associated software costs would be those to upgrade from one type of computer to another. These costs are generally minimal. Conversely, because of the capabilities allowed through available software applications, software costs and the proliferation of new applications have become the driving factor when determining the solution to computing requirements. This paper describes an approach and suggests a solution to the current dilemma that the

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

government finds itself in, of over regulation and auditing requirements with seemingly no obvious understanding of the technology and how it is applied.

DEVELOPMENT

A primary factor contributing to this phenomenon of over-control at the wrong level is the perceived inability to trust the user (or customer) to control costs on the computing systems used in the workplace. This over control also implies that the user does not understand the tool on his desktop. This is an incorrect assumption. Today's computer users have become so comfortable (in general) with the desktop computer that it is considered little more than another administrative tool. In today's technology, the government's emphasis is being placed on the wrong component of a computer system, either the hardware platform or the total system (hardware plus software). A more practical approach to meeting the users' requirements while also controlling costs is some level of software standardization. This approach looks at the software and considers the hardware nothing more than an enabling tool. This also supports the need for increased standardization, linking and integration of the different applications[5].

The Federal government uses two types of software, commercially developed and available and custom developed for specific applications or functions. Although more and more commercially developed and produced software is being used within the government we still have a tendency to custom develop more than is appropriate or necessary. Even when we custom develop, we do not tend to look at other agencies or sites that have already had software developed that could be modified for other uses. Additionally, we are still very poor at requiring the proper documentation and rights to source code. Software designed and developed for specific Federal (including Defense) applications have had much attention paid to them. Therefore, there are a myriad of specifications, standards and processes written and applied to that issue. That aspect of software control requires separate attention and will not be dealt with in this paper.

There has not been a proportionate degree of attention applied to the use of commercially developed and Federally used software. In the commercial software arena, we (the government) have failed to standardize on even basic administrative software, thus incurring unnecessary costs by acquiring multiple software application programs that accomplish the same purpose but are needed to read or write to others in our community (co-workers or associates at other sites).

Use of commercially available software instead of custom developed software is strongly promoted within the Federal government. One of several reasons for this is that many of the functional needs of the Federal government personnel are general purpose in nature. These general purpose functions are the same as that for any other organization, business or personal requirement. As a result, there are many applications written for any type of business or personal function that can be hosted by multiple operating systems and any level of computer system (single to multi-user) in the commercial market place. Therefore, the application development costs have already been borne by a commercial developer. As a result of the fact that this developer has a very wide customer base and his product is competing with x quantities of other companies similar application products, the cost is comparable to all other similar programs or products on the market. It is

generally more cost effective to buy a commercially developed business program product than custom design and develop a program for Federal application. This would support the Federal government's position on using commercial applications over custom developed applications. Unfortunately, the use of the commercial applications has had no standardization applied. The high costs applied to use of computers in the Federal government are in part a result of this.

The Federal government needs to promote and support a reasonable approach or set of standard parameters in the use of commercial applications. Currently, there are no standards within the government for use of software application programs. This problem ripples out from incompatibility within a site or facility to organizations nation wide. This lack of standardization has resulted in a need for multiple software programs to support an individual user's functional needs. An example, word processing, has many program applications written for it and a user needs multiple companies copies in order to read and write to electronically transmitted files or documents. The result of this need to host multiple manufacturers software applications for each function are excessive and runaway costs. This is an unnecessarily wasteful use of Federal funds. This also supports Congress' perception that the individual agencies and customers cannot be trusted to control costs.

CONCLUSION

Federal control (standardization) for commercially available software application programs at the format level would allow individual users the ability to use the computing technology tool of their choice while using a standardized and cost effective approach to the acquisition of the software programs. The Federal acquisition and use method would then be more consistent with prevailing commercial business practices. The current Federal acquisition process could more easily procure needed software using the preferred competitive method. The control would then be at the more practical application or functional level. I believe that this simplified approach to control would result in a dramatic and immediate downturn of costs applied to our Federal information resources (computers). I believe that this approach would also lessen the requirement for regulations and audit, thereby reducing associated administrative and labor costs.

---

[1]Brooks Act of 1965 Public Law 89-306, (10/65)

[2]Federal Information Resources Management Regulation (12/90)

[3]Jonathan Weber, Los Angeles Times, , "Computer Giants Drag Out Their Big Guns in Workstation Wars" 10 November 1992 sec. D 1-2

[4]Phone conversation with Bill Kert, Ridgecrest Digital Equipment Corporation Branch manager on 15 October 1992.

[5]Datapro, "The Current Status of Technology" April 1992 sec. 1012 1-12

Quality in Federal Procurement

John L. Crum Ph.D.
U.S. Merit Systems Protection Board

An issue of great concern in public administration has been whether the Federal workforce is qualified to carry out the many tasks assigned to it. Research conducted by the U.S. Merit Systems Protection Board attempts to answer this question for the more than 30,000 people employed as Federal contract specialists.

This research is based on surveys of current contract specialists, their immediate supervisors, members of the Senior Executive Service, and private contractors. Based on these surveys, it was found that although both incumbents and their supervisors were positive about the capabilities of current contract specialists, additional training is needed. Responses from the two client groups indicated that although members of the procurement workforce were capable in some ways, procurement actions take too long and the procurement process does not always serve the best interests of the Government.

Responses from all four groups attribute many of the problems to an increase in the complexity of the procurement process during the last decade. According to respondents, the process has become so complicated that it is often difficult for the average contract specialist to meet the needs of his/her organization in a timely manner while ensuring that no regulations are broken.

Introduction

In recent years, members of Congress and the public administration community have raised concerns about a possible decline in the quality of the Federal workforce and the effect it may have on Government operations. Many have suggested that the refusal to grant pay increases needed to maintain comparability with the private sector over the past decade and a half and the deteriorating image of the Federal workforce have worked together to reduce the number of highly qualified persons employed in the Federal workforce. As noted in several reports by the U.S. Merit Systems Protection Board (MSPB), there is also a perception among many Federal managers that there has been a marked decline in the quality of new hires.

In response to these concerns, both MSPB and the U.S. Office of Personnel Management (OPM) set out to look at the issue of workforce quality. Since the Federal workforce is composed of over 2,000,000 employees (excluding the postal service) working in hundreds of different jobs, it was immediately obvious that it would be impossible if not meaningless to look at the quality of the entire Federal workforce as a whole. Instead MSPB and OPM decided that it would be more effective if each agency conducted separate studies looking at the quality of employees in selected occupations. The occupation chosen by MSPB was contracting specialists, i.e., persons working in the GS-1102 occupational series.

Why study employees working in the GS-1102 series? Simply put, there may be no area where there has been greater concern about the quality of Federal workers and the work they perform than in the procurement of goods and services from the private sector. During the 1970's and early 1980's there were several highly publicized incidents which involved questionable Federal spending. Employees responsible for Government procurements were severely criticized for spending too much money to purchase a variety of products ranging from coffee pots to major weapon systems.

There were two additional reasons for choosing to look at this segment of the Federal workforce. The first was the large number of people employed in this profession (over 31,000 in 1991) and the second was vast sums spent by contracting specialists to purchase the goods and services needed by the Government (contract specialists were responsible for spending over 191 billion dollars in 1990). Given the potential impact that this portion of the Federal workforce on Government operations, even relatively modest changes in the quality of the contract specialist workforce could have tremendous effects on the quality of services delivered by the Federal Government to the American public.

The primary purpose of this study was to determine the quality of both the Government's contracting specialist employees and the work that they perform. Since it is difficult to develop an adequate single definition of what is meant by quality in the area of Federal procurement, this study tried to assess quality from four different perspectives. Two of these perspectives were provided by people currently working in Federal procurement—current contracting specialists and

their supervisors. The other two perspectives came from clients for the services provided by contract specialists—members of the Senior Executive Service and private sector vendors who provide goods or services to the Government under contracts administered by contract specialists. By integrating the perspectives of employees, their supervisors, senior Government managers, and private contractors, we attempted to present a complete picture of the extent to which an important segment of the Federal workforce is accomplishing its assigned tasks.

The information presented in this paper was collected through surveys distributed to each of the four different groups just mentioned. Surveys were sent to approximately 9,300 current contract specialists and their immediate supervisors. These surveys asked employees how well they performed the aspects of their jobs that were identified as critical to successful performance through traditional job analysis techniques. They were also asked to tell us about their backgrounds and the conditions under which they worked. In order to get a second perspective on each employee's performance, we distributed to each employee's supervisor a survey very similar to the one sent to contract specialists. The questionnaire for supervisors differed from the one sent to employees in that it asked supervisors to provide a confidential assessment of their subordinates' performance. Information concerning the quality of service provided by contract specialists was obtained from surveys sent to about 2700 members of the Senior Executive Service and 900 private contractors.

Table 1

Average Self and Supervisory Ratings of Performance on Critical Tasks by GS-1102 Employees

(Ratings Provided for Employees at Grades GS-9 and Above)

Task	Ave. Self Rating	Ave. Supervisory Rating
Conduct market research	3.91	3.70
Review statements of work	3.88	3.77
Determine competition requirements	4.02	3.89
Identify price-related factors	3.63	3.59
Review business management factors	3.73	3.63
Identify contract type	3.93	3.78
Prepare requests for proposals	4.14	3.92
Determine low bids	4.02	3.89
Review technical evaluations	3.91	3.75
Evaluate offers	3.95	3.76
Conduct cost analysis	3.91	3.72
Determine competitive range	3.91	3.74
Develop negotiation strategy	3.87	3.68
Conduct negotiations	3.90	3.75
Determine standards of responsibility	3.98	3.84
Respond to protests	3.63	3.57
Monitor compliance	3.81	3.71
Identify contractual remedies	3.67	3.56
Determine contract modifications	4.05	3.84
Research claims	3.60	3.57
Average for 20 tasks	3.87	3.73

Views From the Procurement Workforce

In completing our survey, employees were asked to rate their own performance using a five-point scale on 20 job tasks that had been identified as critical to the work performed by contract specialists by the Federal Acquisition Institute. Employee and supervisory ratings on each of the 20 tasks are shown in table 1. A response of "1" meant that they believed they were unable to perform the task and a "5" meant that they performed this task exceptionally well. A "3" meant that they performed this task at an acceptable or average level.

Comparisons of the performance ratings provided by both employees and their supervisors showed that both groups were quite positive about the quality of the work performed by members of the contract specialist workforce on these 20 critical tasks. In fact, the overall mean rating of 3.87 indicates that the overwhelming majority of employees (on average, 65 percent of the employees) thought that they performed these tasks in an above average manner. Supervisors also rated their employees positively but slightly lower, with an average rating of 3.73 (reflecting that, on average, 58 percent of the supervisors reported that their subordinates performed these tasks in an above average manner).

To the extent that self and supervisory ratings of performance on these 20 critical tasks are indicative of quality, it would appear that the quality of work performed by members of the GS-1102 workforce is quite high. Even so, apparently a relatively large percentage of both employees and supervisors believed that there is substantial room for improvement since, on average, one-third of both the employees and their supervisors said that contract specialists need at least a moderate amount of additional training with regard to each of these tasks.

The fact that so many employees and their supervisors claimed that additional training was needed would appear to contradict the fact the vast majority of the employees (on average, 96 percent) said that they were performing at least adequately. This apparent discrepancy was at least partially explained in written comments received from numerous employees in response to the survey. According to our respondents, they simply cannot keep up with the changes occurring in both the Federal Acquisition Regulations (FAR) and agency implementation of these regulations. As a result, training is continually needed in order to keep current with the ever-changing Federal contracting environment.

Table 2

Self and Supervisory Ratings of Abilities Essential to the Work of GS-1102 Employees

(Percent of GS-9 and Above Employees Rated "Adequate" and "Outstanding")

	Self Ratings		Supervisory Ratings	
Ability	Adequate	Outstanding	Adequate	Outstanding
Directing Work Activities	50	41	54	28
Planning and Organizing	42	52	50	37
Human Relations Ability	46	46	52	32
Analytical Ability	47	45	48	37
Oral Communications	47	46	52	37
Writing Ability	46	46	51	33
Ability to Innovate	54	32	53	22
Ability to Initiate Action	48	45	50	34
Conducting Negotiations	48	36	49	33
Average	48	43	51	33

In addition to collecting information concerning performance of work-related tasks, our survey asked employees to rate themselves on nine basic abilities that were identified as essential to performing the contract specialist duties, again as identified by job analyses conducted by the Federal Acquisition Institute. These abilities are listed in table 2.

As shown in this table, on average, 48 percent of the employees rated themselves adequate in terms of these abilities, while 43 percent rated themselves outstanding. By comparison, supervisors rated their subordinates as adequate 51 percent of the time and outstanding 33 percent of the time. Nevertheless, once again, the results indicated that there is substantial room for improvement with regard to each of the nine abilities since many employees and their supervisors believed that additional training is needed in each of these areas. On average, supervisors reported that 55 percent of their subordinates need additional training in terms of these nine abilities. Both employees and supervisors agreed that the area with the most room for improvement was conducting negotiations. For their part, supervisors also thought that significant improvements could be made through training in analytical ability and the ability to write.

Another important measure of the quality of an employee's work is the official performance appraisal rating that a supervisor is required to give each subordinate every year. Until recently, this rating was normally provided using a five-point scale, running from "unsatisfactory" (or "1") to "outstanding" (or "5"). Employees responding to our survey were asked what rating they had received during their most recent formal performance appraisal. In response to this question, 31 percent said that they were rated "outstanding" and 45 percent "exceeds fully successful." Only 24 percent indicated that they had been rated "fully successful." Fewer than 1 percent said that they had been rated "less than fully successful." Similar distributions of ratings were reported for each of the previous 2 years as well.

Unfortunately, the formal performance rating given to an employee each year can be influenced by a number of factors other than the employee's work performance. In fact, research by OPM has shown that when supervisors were asked to provide confidential ratings on the performance of employees they supervised, these ratings were frequently significantly different from the official performance rating they gave the employee. For this reason, we decided to ask supervisors to provide confidential ratings of their subordinate's performance. As was done when providing an employee with an official performance rating, supervisors were asked to rate employees on a five-point scale, with a "1" being assigned to the lowest rating and a "5" to the highest. Figure 1 shows the distribution of both the most recent official ratings reported by employees and the average overall research rating provided by supervisors for their subordinates.

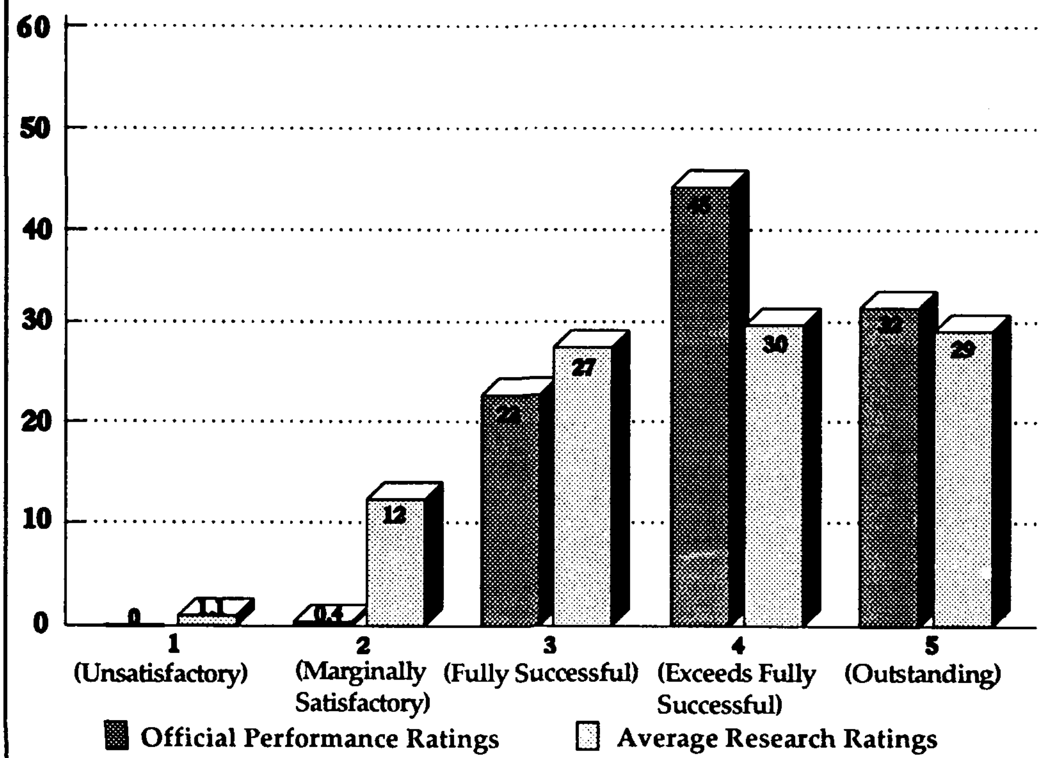
As this chart shows, supervisors frequently gave lower ratings to their subordinates when asked to provide confidential ratings of employee performance than employees reported were given to them in conjunction with the official performance appraisal process. Nevertheless, the research ratings we obtained are still fairly high. In fact, over 59 percent of the employees received average research ratings that placed them in a category above "fully successful." Clearly, in terms of both the formal performance appraisal ratings and the confidential research ratings, supervisors believed that the contract specialists who work for them generally do a good job.

In addition to analyzing ratings on abilities, performance of job-related tasks, and overall performance, we collected information on a number of additional factors that could be related to the quality of work performed by Federal contract specialists. This included information concerning the formal educational backgrounds of contracting specialists. The issue of education is one of particular concern among senior management officials in procurement. In discussions with these officials, it was suggested that too few of the people entering the GS-1102 series during the last 10 to 15 years had completed sufficient levels of education to prepare them to perform their work.

Given the concerns expressed to us by senior officials in procurement, it was somewhat surprising to find that over half (56 percent) of the people working in this area have earned at least a bachelor's degree and about one in six has obtained at least a master's degree. There was some evidence, however, to support the contention of many senior procurement managers that persons entering the GS-1102 series during the last 10 to 15 years were somewhat less likely to have achieved the educational level attained by those who entered the contract spe-

Figure 1

Disribution of Official and Average Research Ratings for GS-1102 Employees



cialist workforce before that time. A breakdown by length of time working in the GS-1102 series revealed that over 61 percent of the persons working in this series for 15 or more years had attained at least a bachelor's degree. By comparison, slightly fewer than 53 percent of the people entering this series during the last 15 years had completed the same level of education.

Self reports of grades obtained in school also suggest that employees did quite well in the course of getting their degrees. The overall grade point average (GPA) reported by contract specialists who completed college was 3.13 on a four-point scale. Moreover, the GPA for the employee's last 2 years was 3.29 and 3.35 in his or her major field. Additionally, more than 75 percent of the employees reported that they were in the top 25 percent of their graduating class.

Based on the results just presented, it is clear that in terms of the direct match between critical job requirements and workforce characteristics, both supervisors and employees believed that the quality of the procurement workforce is at least adequate, if not superior. Even so, supervisors, in particular, reported that there is substantial room for improvement as indicated by their belief that significantly more training is needed for large portions of the workforce. Perhaps even more importantly, comments provided by both employees and supervisors in response to our survey revealed that there were a number of potentially substantial problems which both groups believed limit the quality of the work performed by contract specialists.

Literally thousands of comments were received from both employees and supervisors, many of whom repeated the same themes. One recurrent theme among the comments provided by employees was the belief that contract specialists are being overwhelmed by changes to the procurement process. According to many of these contract specialists, this situation was frequently made even more difficult since either adequate money for training was not available in their organization or their work load was so heavy that they were not permitted to take the time to attend training.

From the perspective of the supervisors who provided written comments, the main problems facing the procurement workforce were the volume of the work and the complexity of the procurement process. Of course, these problems are interrelated. As was the case with the contract specialists themselves, these supervisors reported that the procurement process has become so complex that the even small procurement actions can take an inordinate amount of time and involve excessive paperwork. From the perspective of these supervisors, there are so many rules that contract specialists in many agencies have little or no discretion. Unfortunately, these same supervisors thought that this sometimes led to procurement decisions that seemingly made little business sense.

The increasing complexity of the procurement process frequently also has the effect of lengthening the procurement process and, as a result, there was constant pressure from management to speed up a process that has been slowed down by regulatory requirements. According to some employees, this sometimes resulted in a tendency for management to put tremendous pressure on contract specialists to bend the rules.

For many employees the situation becomes all but intolerable at the end of the fiscal year, when organizations are concerned with spending all of the money allocated to them so that they do not lose this money or have their budgets cut the following year. In their written comments, a number of respondents told us that their organizations were more interested in obligating all of the money they were budgeted before the end of each year than they were in making sure that procurements are made in conformance with applicable rules and regulations.

Although contract specialists may be pressured to complete contracts and obligate dollars as quickly as possible, their agencies are legally responsible for the integrity of the contracts they write. Despite pressures of the sort described in their written comments, apparently most employees recognized that breaking the rules is not an acceptable response. In fact, discussions with senior procurement officials concerning the interpretation of survey results suggested that the emphasis on legal and defensible contracts may be so great in some organizations that it has become the overriding concern in the minds of many contract specialists. According to one supervisor: "Playing it safe and by the book is what gets rewarded." This is not to say that supervisors were suggesting that employees should break the rules, only that the emphasis has shifted from finding legal ways of meeting the needs of the organization to being sure to protect oneself.

Although it is certainly important for a contract to be able to stand in the face of a protest, too much emphasis on protecting oneself apparently fosters a closed-minded approach to contracting. According to many supervisory comments, this type of thinking can lead to an authoritarian enforcement mentality where contract specialists rigidly apply the rules that they have learned, often without adequate understanding of the options available to them and sometimes even without a sufficient appreciation of the missions of the organizations they support. This type of thinking probably also contributes to the belief held by many supervisors that their subordinates lack the ability to innovate and lack creativity.

Based upon both survey responses and written comments, it appears that while supervisors believed that most of the people who worked for them had the ability to perform the tasks required of them under the best of conditions, they also thought that their subordinates seldom possessed the abilities needed to devise creative legal solutions to organizational problems given the situations in which they typically find themselves. As a result of the complexity of the Federal procurement system and organizational pressure to obligate all allocated money, contract specialists were frequently faced with a dilemma of how to provide the service required by their organization without breaking the rules. Unfortunately, under these conditions it appears that only those employees possessing an unusual amount of analytical ability and creativity were able to successfully meet both of these goals. According to supervisors, employees possessing these abilities to a lesser extent typically either chose to bend the rules or developed an inflexible approach to contracting that may alienate managers in the organizations in which they work.

Client Views of Procurement Workforce Quality

In addition to information provided by persons working in procurement, valuable information about workforce quality can be collected from the clients for whom goods or services are obtained. For this reason, a third and fourth perspective of procurement work quality was provided by persons who were, in a real sense, clients

for the work performed by contract specialists. One facet of client satisfaction was provided through information collected from a survey of current members of the Senior Executive Service. An additional perspective was obtained through surveys sent to private sector companies that currently have contracts with the Government and whose representatives have extensive dealings with Federal contract specialists. Persons responding to each of these surveys were asked about the overall effectiveness of Federal procurement practices, the quality of products provided to the Government by the private sector, and the quality of work performed by the individual Federal contract specialists with whom they deal.

In analyzing the results of our surveys we were somewhat surprised to find that in many ways the senior executives responding to our survey thought quite highly of the contract specialists who supported their organizations and, as shown in table 3, both the senior executives and the private contractors viewed several aspects of the work performed by contract specialists quite positively.

Although senior executives were generally positive concerning many aspects of the work performed by contract specialists, they did indicate that there was room for improvement in several areas. For example, senior executives were somewhat less satisfied about the extent to which people working in procurement maintained a positive service orientation towards clients or colleagues in their organization. Similarly, 38 percent of the senior executives said that with the possible exception of some routine tasks, work by contract specialists supporting their organization was usually not completed in a timely manner.

As was the case for supervisors, a very common theme in the comments provided by members of the SES was that too many contract specialists were "rule-bound" and prone to attempt to apply

Table 3

SES and Contractor Opinions Concerning GS-1102 Employees

(Percent of SES Members and Contractors Responding to the Question "Federal contract specialists (are):")

	SES Members		Contractors	
Item	Agree	Disagree	Agree	Disagree
Knowledgeable about Federal procurement procedures.	90	4	68	15
Apply Government regulations accurately and fairly.	79	8	58	20
Well trained.	74	13	63	24
Generally helpful.	74	14	66	16
Provide prompt responses to questions.	62	21	56	29

Notes: 1. The column labelled "Agree" includes both "Strongly Agree" and "Tend to Agree" responses. Similarly, the "Disagree" column includes both "Strongly Disagree" and "Tend to Disagree" responses. 2. "Neither Agree nor Disagree" and "Don't Know" responses were omitted.

rules blindly to a variety of contracting situations without adequately understanding the objectives, goals, or mission of the organization. These same senior executives tended to see contract specialists as myopic defenders of contract regulations rather than as team players whose purpose was to get the job done effectively. As such, contract specialists were seen as more inclined to follow a procurement cookbook than to look for innovative and legal solutions to organizational needs. This perception on the part of some SES members was also reflected in the responses to a question about the creativity of the work performed by contract specialists.
Approximately 39 percent of the senior executive respondents said that the contract specialists supporting their organization showed inadequate creativity in their work.

Although critical of their contract specialists in the aforementioned ways, senior executives recognized that some of the concerns they raised may have resulted from the conditions under which contract specialists frequently must work. For example, 58 percent of the SES members said that contract specialists who supported their organization were too often asked to perform difficult tasks under tight time constraints (only 20 percent disagreed). Additionally, most (51 percent) indicated that contract specialists were often under undue pressure as a result of having too much work to perform.

As was shown in table 3, private contractors also held a generally positive view of Federal contract specialists in at least several areas. Like the senior executives, contractors felt that Federal contract specialists were basically knowledgeable, well-trained, and helpful. Even so, they tended to be somewhat less positive than were the senior executives with respect to the same items.

Responses to other items on the survey revealed that there were also areas of significant concern among private contractors. Although 85 percent of the contractors said that their firm has a good working relationship with the contract specialist assigned to their contract, almost one-third of these same private sector respondents did not think that contract specialists were prepared to discuss substantive issues concerning the contract. Additionally, almost one-third did not believe that contract specialists provided prompt responses to their questions.

Both the contractors and the senior executives were also asked a series of questions concerning the Federal procurement process. Generally, the views of private contractors concerning the Federal procurement process were very similar to those held by the SES members. As table 4 indicates, both groups had very little positive to say about the procurement process.

Among members of both groups there was a general consensus that the Federal procurement process does not effectively reduce waste, fraud, or abuse, and does not serve the best interest of either the Government or private contractors. Both the contractors and the senior executives were negative about the procurement process in several additional ways. For example, 63 percent of the contractors felt that the contracting process is too time consuming, and 58 percent said that the process for awarding contracts is too cumbersome. Similarly, the vast majority of SES respondents said that the Federal procurement process takes too long (91 percent) and involves too much "red tape" (89 percent).

Like the contract specialists and supervisors discussed earlier, both senior executives and private contractors believed that the main problem is that the Federal procurement process has become far too complicated. From the point of view of the senior executives, the complexity of the Federal procurement system has simply exceeded the capabilities of the contract specialists who support their organizations.

According to both SES respondents and private contractors the complexity involved in processing procurement actions has greatly increased over the last 10 years. Unfortunately these same respondents did not believe that the quality of the Federal contract specialists has undergone a similar increase. In fact, although contractors often appreciated attempts by contract specialists to make things flow smoothly, many also thought that most contract specialists were not able or adequately prepared to work effectively, given the intricacies of the procurement process.

From the point of view of members of both client groups this leaves the Government with only two alternatives. According to one respondent, either: "The entire procurement system needs to be simplified and made more efficient" or "the quality of the people operating the system has to improve."

TABLE 4

SES and Contractor Opinions of the Federal Procurement Process

(Percent of SES Members and Contractors Responding to the Question "The Federal Procurement Process":)

Item	SES Members Agree	SES Members Disagree	Contractors Agree	Contractors Disagree
Effectively reduces the incidence of waste, fraud, and abuse.	39	40	29	39
Serves the best interests of the Government.	34	47	42	36
Serves the best interests of private sector contractors.	25	45	11	65

Notes: 1. The colums labeled "Agree" include both "Strongly Agree" and "Tend to Agree" responses. Similarly, the "Disagree" columns include both "Strongly Disagree" and "Tend to Disagree" responses. 2. "Neither Agree nor Disagree" and "Don't Know" responses were omitted.

Conclusions

Based upon the responses of contracting specialists and their supervisors it appears that the members of the Federal procurement workforce are at least basically qualified to perform their jobs. Contract specialists generally believed that they possess the skills, knowledges, and abilities that they need, and to some extent their view is substantiated by the large percentage of employees who received high performance appraisal ratings. However, most members of the current workforce said that additional training is required, both to perform critical tasks better and to stay abreast of changes in regulations.

Supervisors were also positive about the capabilities of their subordinates, but overall presented a picture of a somewhat less able workforce than did the employees themselves. Although supervisors believed that their subordinates possessed at least acceptable levels of required skills and abilities, they also thought that there was considerable room for improvement. In many cases, supervisors saw additional training as a way to improve. This was especially true with regard to the ability of their subordinates to conduct negotiations, to write, and to be analytical.

Given the concerns of supervisors, SES members, and private contractors, it is apparent that there are significant problems and dissatisfactions with the work performed by contract specialists. The primary factor behind these problems appears to be the inability of contract specialists to deal with the increasingly complicated requirements under which they must work. As the number of regulations has increased, so has the complexity of job requirements and the amount of time it takes for a contract specialist to complete many purchases. Under these conditions it is not enough to possess merely adequate skills. Rather, to do a good job in today's work environment, it appears that most contract specialists need a high degree of both analytical ability and creativity. Unfortunately, these were exactly the skills both supervisors and members of the SES believed were most often lacking in contract specialists.

Recommendations

How can we correct this situation? Basically, MSPB believes that improvement can occur as the result of several actions which are discussed in the following four recommendations.

Recommendation 1: Provide Additional Training to Improve the Quality of the Current Workforce

Based upon the results of this study, contract specialists need to be better prepared to make the best possible business decisions for their organizations in a timely manner. According to the assessments provided by procurement supervisors in response to our survey, training should be directed towards improving the capability of the workforce to conduct negotiations, analyze requirements, write clearly, and develop innovative solutions to meet organizational needs.

Training is particularly important since almost half of the current procurement workforce has fewer than 7 years of experience in the occupational series. Moreover, approximately three-quarters of the people employed in the GS-1102 series currently work for one of the Defense agencies. Since it is clear that the immediate future will bring reductions in the size of the Defense budget, it is unlikely that the total Federal procurement workforce will continue to grow as it has since 1981. For this reason, any marked improvements in the quality of the procurement workforce are <u>not</u> likely to come from large infusions of highly qualified new workers. Significant improvements in workforce quality can only result through an improvement in the capabilities of current GS-1102 incumbents.

It is also important that any training in procurement that is provided addresses a key issue: how to make informed business decisions that permit an organization to purchase goods and services needed to meet mission objectives in a cost-effective manner. In order to do this, people need to be trained in the philosophy of procurement. This includes a better understanding of the mission of their organization and the role they play in purchasing the goods and services needed to meet organizational requirements. At some level this probably also involves an understanding of the private sector businesses with which they will be dealing.

Recommendation 2: Encourage and Reward Creativity

Our study found that both employees and their supervisors believed that most of the people working as Federal contract specialists have the skills, knowledges, and abilities needed to perform well. In the final analysis, however, the customers for the services provided by contract specialists are often not satisfied. To some extent, inappropriate or inadequate supervision may contribute to this result.

Although supervisors of contract specialists criticize their subordinates for a lack of creativity, it is the supervisors who must bear at least some of the responsibility for this state of affairs. It is the supervisors who set the tone for the organization. In many cases they choose to reward "rule-bound" approaches to contracting and discourage their subordinates from being more creative and using the flexibilities that are currently available to them. If contract specialists are to be more creative, supervisors need to foster an environment in which employees are not afraid to be innovative. Through their leadership, supervisors need to show employees how they can be more responsive to their customers without breaking the rules.

Recommendation 3: Ensure Quality of Selections Made for Entry-Level Positions

According to many supervisors, there has been a decline in the quality of new entrants to the GS-1102 series over the last 10 to 15 years. While there is only minimal evidence to support this contention, it is clear that the skills, knowledges, and abilities needed by contract specialists have increased in number or complexity. For this reason, efforts designed to improve the quality of selections for GS-1102 vacancies are important. Over time, an improvement in the quality of the people becoming contract specialists can have a major impact on the quality of Federal procurements.

In at least the recent past, supervisors of contract specialists have not always looked to all possible recruitment sources. Very little use in filling vacancies has been made of the persons available through the Presidential Management Intern Program or OPM's recently developed Administrative Careers with America (ACWA) procedures. In our view, an improvement in the quality of new entrants to the GS-1102 series can be made through greater use of the applicants who are referred for consideration through either use of the ACWA procedures or the Presidential Management Intern Program. Additionally, when considering current Federal employees for placement into entry-level procurement (GS-1102) positions, managers should use a wide area of consideration to gather a pool of high-quality applicants from a broad range of occupations and Federal organizations.

Recommendation 4: Where Possible, Streamline and Simplify the Procurement Process

The organizations charged with oversight of the procurement process must constantly strive to provide regulatory and procedural safeguards against abuse while still allowing room for the exercise of reasonable judgment on the part of contract specialists. Contract specialists, their supervisors, and their clients all suggested that a reasonable balance in this regard has not been achieved in that the system tilts too heavily towards overly elaborate regulatory requirements and procedures. Too often, it was reported, procurement or contract decisions could not be made in the best interests of the Government and the taxpayer because of the lack of flexibility. For this reason, some simplification of the procurement process could actually improve its efficiency and cost-effectiveness.

SUBCONTRACTING WITH EASTERN EUROPEAN RESEARCH FACILITIES - WHAT TO EXPECT

Fred Cyran, P.E., Maxima Technical Services

ABSTRACT

Recent improvements in technology transfer between the U.S. and Eastern European nations have resulted in an "All Our Services are For Sale" attitude on the part of Eastern European enterprises. As state-owned facilities have been or are being privatized, many directors of established institutions are now in the process of learning how to prepare proposals to win contracts in a competitive environment.

A team venture was organized between a U.S. firm and a Polish research facility to bid on a U.S. government contract involving basic research. Since the Polish facility possessed a specialized expertise required by the Request for Proposal (RFP), the technical aspects posed no problems. However, obtaining definitive cost estimates and the basis for those estimates from the Polish facility was somewhat challenging. Even more difficult was the necessity of tutoring the facility directors on the philosophy and fundamentals of selling services to the U.S. government.

This paper summarizes the experience of a U.S. design firm teaming together with a subcontractor from an Eastern European high-tech research facility currently undergoing the privatization process. As a result of this experience, it was concluded that future relationships can be established without insurmountable problems if adequate planning is done prior to the issuance of the RFP. In addition to the need for patience, an understanding of the expected challenges can be useful to U.S. firms and government agencies in establishing subcontractor support with Eastern Europe.

INTRODUCTION

A small but growing number of U.S. companies are finding that Eastern Europe has strong research and development resources available at relatively low cost. A well-educated scientific community is readily obtainable. High-tech research facilities are common in these countries. But since only a small portion of the work carried on in these facilities during the communist era ever made it to Western technical conferences and journals, many U.S. firms are unaware that these facilities even exist. A large amount of technical data and publications from these facilities also exists. This information is maintained in the libraries of these facilities, and cannot be found through Western literature searches.

While much of their technology is behind the state-of-the-art of the West, there are often isolated areas of technological research or capabilities that exceed that found in the U.S. Historically, research efforts in the former Soviet bloc were not based on a profit motive. Instead, they followed a more academic interest in their area of specialization. They have a keen interest in fundamental science and understanding physical phenomena. Often their research was aimed at solving practical problems, as opposed to innovating new technologies.

Eastern European research facilities have the same attitude towards the West as most other enterprises. They desperately need

capital and want better relationship with their Western counterparts. They are very receptive to building international exchange programs, joint research, and a general exchange of ideas.

Many facilities are fighting for their financial survival. In the past, some were completely subsidized by the government. As market economics are being gradually phased in, government subsidies are being lowered or phased out entirely. Directors of these facilities are learning by their own experience the importance of marketing their services to secure U.S. funded work. These institutions are not looking for handouts. Rather, they want to jointly develop research opportunities, and to acquire state-of-the-art research equipment. This creates favorable fee ranges. Sometimes attractive barter arrangement are available (usually their brainpower for Western computers and high-tech hardware). It is not unusual to procure quality contract research at half the cost of doing similar work in the U.S.

Quality work at low cost is not without it's problems in Eastern Europe. Many of the most basic principles of project management, instinctive to U.S. firms, are seriously lacking at all levels. These shortcomings can occur in the form of cost estimates without basis, inability to anticipate factors affecting schedule, and a tendency to "drift" off of technical objectives in pursuit of tangent interests. But what they lack in management, they make up for in superior technical capabilities. This is the key to a successful joint research project - U.S. management leadership, coupled with their excellent scientific aptitude.

The opportunities of Eastern European facilities is by no means a buyer's paradise. Many joint research projects fail because of communication gaps and a lack of understanding about what can be realistically accomplished. A successful project in Eastern Europe requires a good understanding of the culture, attention to detail, adequate planning, and the determination to establish a long term relationship. This is not an environment to expect quick profits or breakthroughs. But finding a common research interest with them can reap handsome dividends.

The best method of informing U.S. firms of what to expect from working with Eastern Europe facilities is by citing a recent experience on a joint project. The information contained in this paper is based largely on a U.S. aerospace firm's subcontracting relationship with the Polish Aviation Institute (Instytut Lotnictwa) in Warsaw, a national aeronautical research facility. The technical subject involved contract research in the area of innovative low-speed wings surface contours, fabrication of wind tunnel models, and support of testing their theories in U.S. facilities. The work was being procured by a U.S. government agency via a Request for Proposal (RFP).

ESTABLISHING CONTACT

Finding a suitable research facility in Eastern Europe is generally not very difficult. However, the topic of locating such a facility is beyond the scope of this paper. Numerous consultants are available in the U.S. who specialize in technology transfer with Eastern Europe and in locating industries or state-related agencies that conduct high-tech research.[1] Once a candidate facility is located, establishing a dialogue is relatively easy. The next step is to write or fax a letter of inquiry to them directly, in the English language, addressed to the facility director. They will typically respond with an English response letter giving the name of an

English speaking contact at their facility and a short, general flyer on their capabilities. As their postal system and internal bureaucratic organization is generally inefficient, it is not uncommon for letters or faxes to be lost in transit. Generally sending information by fax is more effective than mailing letters. Do not be discouraged if two or three correspondences are needed before you get an answer. However, once an appropriate contact in their organization is identified, communication will usually improve. Initial contact will be faster and more effective if a consulting firm is used, or if the U.S. organization has personal knowledge of an individual working in their field of research.

NECESSITY OF SITE VISITS

In the case of the author's relationship with the Polish Aviation Institute, previous contact and visits were established prior to the release of an *RFP*. Had a detailed description of their capabilities not been known, establishing a relationship in the short period needed to respond to an RFP would not have been possible.

Typical Eastern European research facilities have relatively poor and unorganized marketing literature on their capabilities. All facilities have some information, often in English. However, they do not have much experience in providing colorful and appealing sales literature. Their translation into English may be less than desirable. Often their statements of capabilities are prepared on a typewriter and duplicated in mass. Such literature is still valuable for the technical specialist, who can sift through the information to determine if the facility has potential capabilities.

A visit to their facility is a necessity. Language should never be considered a problem. Virtually all facilities have at least one person on their staff who speaks English and is knowledgeable of their area of specialty. This is normally sufficient to conduct a tour and discussion of past projects and capabilities. If the U.S. firm knows the subject matter well, technical communication should not be a problem. Cordial, hospitable visits are the norm, because of eagerness to establish ties with the U.S. They are usually generous in providing samples of their work, along with an extensive tour of their facilities. They are also eager to introduce their staff and present their latest research. In fact, it would not be unusual if they reveal more about their strengths and weakness than would be expected from an American firm.

A visit to an Eastern European facility, especially those previously state-owned, can be discouraging. Much of their equipment is vintage 1940-50 in both style and function, but is *usually functional and* well maintained. Scattered throughout the facility will be selected high-tech equipment produced in the last 20 years. Data acquisition equipment, for example, generally does not compare with the West. However, it is usually simple and practical. It will be obvious that little money was available to procure the latest equipment. The humble appearance of the site must be overlooked to achieve your objectives: finding a specific technology where they have expertise in spite of their equipment shortcomings. Whereas the overall facility may be obsolete by Western standards, there may be a few areas which are highly advanced.

TEAMING

Once an area of re. earch has been identified, the potential applications should be discussed with the technical management of the facility to determine their interest, and

more importantly, to begin the formation of a research team. In some cases they may have had joint projects with other facilities, either in their own country or other facilities in the Soviet bloc. They may be hesitant to mention other contact or inquiries with Western firms for fear of damaging their relationship with them. Inquiries and involvement with Western firms are probably more extensive than commonly believed. But since many inquiries do not result in establishing a joint project, they may not want to openly discuss them.

It is also typical that your initial relationship with them may cool somewhat after your site visit. This stems from their expectations that you want to engage them immediately for a specific work effort. If they perceive that you are only considering potential work, as opposed to an aggressive interest to retain them, them may lose interest and be unresponsive. This attitude results from their more common dealing with Western European firms (typically German, Dutch, Austrian and French), who deal with them differently than their U.S. counterparts. They may also be unresponsive if bureaucratic delay occur in your planning or funding authorization.

When suitable capabilities are identified, and candidate researchers have been identified by name, a short (1-2 page) letter of intent should be submitted from your organization to their facility. They should respond back with a letter from the facility director that they intend to support the program you describe, with the people previously named, and that they are willing to enter into contractual negotiations to identify the detailed scope, schedule and budget within a fixed period of time.

If the candidate project involves the submission of a proposal in response to a U.S. government RFP, a significant effort will be needed to explain the U.S. government procurement process to them. Unless their portion of the work is small, there will probably not be enough time to educate them on the basics of the process. It is difficult for them to comprehend the competitive nature of proposal submission. It is even more difficult to get their full and timely support on a proposal they may not win. If they do give their full support, they may assume that a contract is assured - losing sight of the possibility that award may be delayed, canceled or lost to another bidder. Such an experience will discourage further association with your organization. To alleviate this kind of a situation, the need to educate the management of the Eastern European facility on standard U.S. government protocols can not be overemphasized.

Throughout your entire correspondence and teaming efforts, an aggressive, pro-active attitude must be maintained towards them. They are typically reactive, and function well if presented with a specific technical problem needing solution, rather than asking them for conceptional studies, proposals or administrative data. They will also be very disinterested in your project if you expect them to respond with elaborate proposals describing non-technical issue (as they perceive them). You will get a better response if you ask for a specific solution to a technical problem. If you say "This is the problem we have. Can you solve our problem or determine what is causing it", you will get a better response than if you say "Could you propose several concepts in this particular area where you are interested in working, and provide a preliminary plan on how to accomplish this work"? In all your communications, it must be remembered that their great strength is in technical problem solving. To be successful

the U.S. firm must take the lead in managerial and administrative matters.

COMMITMENT

A common discouragement to U.S. firms is talk without action. Additional written information, future appointments, output samples and follow-ups to action items are sometimes promised and not delivered. This is not intentional, but is rooted in living under the former highly bureaucratic communist system. They may repeatedly mention their desire to do business with you, but won't seem to take any action on their part to initiate such work. When they say they desire to do business with you, they really mean it. But hidden in their enthusiasm, there will often be a plea for you to tell them specifically what needs to be done to make this a reality. Another frustration is the "it's in the mail" response. Often this is true. They may tell their secretary to mail certain material to you, which is subsequently mailed via the slowest, least costly means. Also, directors and administrators may change suddenly, with no transfer of knowledge of current activities between them and their successors, causing additional frustration.

To be effective, it may help to consider some aspects of what business was like in the U.S. in the 1930's. For example, they react favorably to the old fashion method of dropping in on them, in person, to conduct business. This is far more effective that doing business via mail or telephone. Perhaps you will find the right people there at that time. Perhaps not. But you will probably have the same success as if you scheduled appointments with them in advance. Team members from the U.S. may have to adjust to this style of conducting business, which is generally the opposite of what Americans expect or are accustomed to. Retaining the services of an American representative in the Eastern European country is also recommended. This will help you understand the business and cultural practices, minimize frustration, save time and give you strategic advice leading towards constructive negotiations with their facility.

Commitments for specific projects must be negotiated in person, preferably at their site. A general rule to follow in estimating how much time it will take to scope the work and prepare a plan for joint cooperation is 2-3 times the amount of time required to do similar preparations in the U.S. Normally this will involve multiple visits of multiple days at a time.[2] You must demonstrate that you are willing to take the lead, and need their support to make the project successful.

You will need to prepare the bulk of their proposal. This is best done by submitting to them a draft for the technical scope of work you expect them to do, along with a work breakdown structure on how you envision them to accomplish the work.

Some principles to observe during the commitment stage:

- It is essential to keep the definition of what research is expected as simple as possible. A excessively complicated project has a much greater chance of failure.

- Consider only technologies in which both your organization and the Eastern European facility have expertise.

- Do not be discouraged by their lack of business tact. It is unrealistic to expect that their preparation, organization, and courtesy will be

similar to a U.S. firm. They may not be bashful in expressing their own wants and desires, without any empathy for your organization's objectives.

COST ESTIMATES

You should not expect to obtain reasonable cost estimates unless you take an active role in preparing the estimates with them. In most cases, there will be no basis for the estimated costs. Historical data and records of prior cost data simply do not exist, or will not be representative of their true cost from a Western perspective. Fortunately, many U.S. accounting firms have offices in Eastern Europe, supporting the large demand to assist local businesses in assembling or reconstructing needed information for cash flow and balance sheet data. These accounting firms can be of great assistance during the estimating process.

The author's first experience with the cost estimating process of the Polish Aviation Institute was interesting. When the subject of estimating the cost of their services arose, an uncomfortable feeling came over the meeting, as if a sensitive issue was raised concerning their integrity. To diffuse the situation, sample cost estimate spreadsheets were presented. The process of estimating the resources for individual work elements was explained, by showing manhours with accompanying labor rates, material costs, overhead, and resource of totals. Their management was not familiar with this kind of a detailed cost estimate format. After about 10 minutes of explaining the basics of developing such an estimate, the mood of the meeting became pleasant. That portion of the meeting ended with the response "Sure, we can do that. We'll just follow your format." These decision makers were people with highly competent technical backgrounds in their area of specialization. They knew their technical subjects. But they needed and expected managerial leadership from the American partners.

To start the estimating process, a general idea of what it will cost to do the similar work in the U.S. is essential. Without this reference point, many directors of technical facilities will quote you a price based on what they think you would be willing to pay them, and not on any basis of their internal cost. The following guidelines should be useful to assist in the development of a cost estimate:

o Procure a general estimate of what it would cost to perform the entire job in the U.S.

o Cut the U.S. estimate in half

o Propose that you have this amount of funds available to allocate to their facility, and ask what they can give you towards meeting your requirements.

o When they agree to do the work for the amount you propose, you must initiate a work breakdown structure with them. This must include both manhours for the personnel they plan to assign to the project, and identification of the kinds of materials. Let them assign manhour rates and cost for the materials.

o Don't expect to receive any quantitative basis for labor costs. Depending on their receptiveness, they will alter the cost to the extent they want the work.

o When you have prepared a rough-draft spreadsheet, identifying the

work breakdown structure and calculated cost, total the complete estimate, review the intended scope of work, and negotiate a preliminary commitment that they can do the work on schedule and at the estimated cost.

o You will need to do essentially all the preparation of documents on the scope of work and the cost estimate. The amount of funds you intend to pay for their work and method of payment will also need to be clearly documented. You may be disappointed if you wait for them to respond with a written response to your request. They are not typically proposal writers; they will look to you to take the lead in the initiation and generation of contract and planning documents.

o Identification of specific deliverable milestones is critical. It must be made clear that specific penalties will be assessed if these milestones are not met. Unless you have a good prior relationship with them, incremental payments for their work normally should be tied to these milestones.

DECISION MAKERS

Facility directors at most Eastern European research facilities have significantly more authority to enter into contractual arrangements and to set prices than their American counterparts. At similar U.S. facilities, authorization is generally needed from a level higher than the facility director. Such approval cycles may cause significant delays in execution of a contact, which may cause them to question the commitment of the U.S. partner. The same applies to price setting. If the facility director is eager for the work, he can negotiate the deal on his own authority. U.S. partners are sometimes surprised at the simplicity of their sales process. They would be ready and eager to accommodate you if you arrived with a suitcase of American currency and wanted to buy hardware or services on the spot.

Depending on the personal contacts of the facility director with key personnel on government legislative committees, leverage of matching funding may be available if the scope of the research falls within national priority guidelines. In Poland, for example, technology that will improve the export marketability of food products could be given subsidies from the government. This may be in the form of funding to purchase equipment or building new facilities capable of meeting the U.S. firm's requirements.

On the U.S. side, leverage may be available in the form of providing their facility with equipment that is slightly older than state-of-the-art. This could be good hardware that the U.S. firms plans to replace with newer equipment. However, credibility could be lost if you offer outdated or low quality hardware. Although they may not have it in their facility, they know and covet quality equipment.

FINALIZING A CONTRACT

The final process of entering into a contract with an Eastern European facility will involve the signing of a detailed contract, the discussion of which is beyond the scope of this paper. It is assumed that throughout the acquisition process, services will be needed from lawyers, bankers, accountants, contract administrators, translators, and export licensing experts, who are familiar with dealing with Eastern Europe. With the exception of banking, none of these support

services should present formidable problems, compared with the technical issues of finding and identifying beneficial joint projects. Banking and currency transfers can be major problems, depending on the particular terms of the contract. This needs to be considered in the early part of the negotiation process.

CONCLUSION/SUMMARY

Eastern Europe offers a highly skilled labor force and high-tech research facilities at relatively low cost. U.S firms can get an excellent return on their investment by taking advantage of this abundant problem-solving brainpower. Much of their capabilities are not well known in the U.S., stemming in part from lack of experience in marketing their services to the West, and from an inefficient infrastructure set in place by the former communist government.

In implementing economic reforms and establishing a market economy, virtually all industries and formerly state-supported research facilities are offering their services to the West to earn hard currency. If a suitable area of interest can be identified between an American firm and an Eastern European research facility, infrastructure and lack of experience should not discourage the formation of a profitable relationship. The key to a successful joint research project is to combine U.S. management capabilities with Eastern European technical expertise.

BIBLIOGRAPHY

1. Kiser, John W., Looking to the East (Eastern European Researchers Looking for Partners), Research & Development Magazine, 02/01/1992

2. PROFILE: One Company's Business Experience in Poland, Eastern Europe Business Bulletin, EEBIC, U.S. Department of Commerce, June/July 1991.

Fred Cyran is president of Maxima Technical Services, 103 Regwood Dr., P.O. Box 366, Tullahoma, TN 37388-0366, (615) 455-6658; FAX (615) 455-0389. The company specializes in assisting U.S. clients in management and marketing of joint U.S./Poland projects and technology transfer.

A PEOPLE-TO-HARDWARE DECISION SUPPORT SYSTEM FOR SYSTEMS ACQUISITION

David A. Dahn, Capt, USAF
Human Resources Directorate
Armstrong Laboratory, Brooks AFB, TX

and

Dr. Lawrence O'Brien and
John S. Park, Jr.,
Dynamics Research Corporation

ABSTRACT

The Manpower, Personnel, and Training (MPT) in Acquisition Decision Support System (DSS) is an Air Force program providing the first integrated tool for addressing MPT requirements during system acquisition and design. New weapon system development and major modifications have historically neglected how our most important and costly resource - people - will maintain and support the fielded system. Inadequate planning for training and deploying the human element has often delayed system operational dates. This DSS will assist acquisition managers and analysts to effectively integrate people issues (numbers, characteristics, proficiency) with equipment (aircraft) early in the acquisition cycle. Acquisition specialists can use the structured analysis approach provided by the MPT DSS to ensure that system people costs are affordable, jobs are properly structured, and people are trained prior to the system becoming operational. The MPT DSS is being designed to support the Human System Integration requirements, now directed under DOD Instruction 5000.2.

INTRODUCTION

New defense systems acquisition or major modifications have historically focused on system costs, schedule, performance, and in recent years - logistics support. Unfortunately, the human element has always been left for last. Human factors experts have made strides to enhance performance and logistics maintenance work, but how we employ our people (recruiting, job descriptions, personnel abilities, training, organizational responsibilities) and their associated costs are often neglected. The opportunities to optimize the human centered elements are enormous. By considering the human capabilities and limitations, beginning with weapon system conceptualization, the human can be eliminated as the factor which currently restricts combat capability; systems can be maintained faster, smarter, and cheaper; people can be trained better, in less time, with higher efficiency; systems can be made safer for the operator, the maintainer, and the non-combat environment. All of this can be achieved by influencing the design of the weapon system to enhance the combat capability through economies of our human resources [1].

In this era of decreasing defense budgets, each system is coming under increasing scrutiny concerning mission need, system requirements, logistics support, and life-cycle costs (LCCs) by both Congress and the Department of Defense (DoD) [2]. This scrutiny drives our need to economize the way we employ our human resources to achieve the best people-to-system tradeoff we can obtain. Every system requires people to operate, maintain, and support it. An Air

Force cost study showed that up to 60 percent of an aircraft's yearly operations and support costs can be directly attributed to manpower, personnel, and training cost elements [3]. As the Air Force's manpower authorizations continue to shrink, and personnel compensation increases, this trend is likely to increase unless new system designs are influenced and adjusted to make the systems easier to operate, maintain, and support with fewer people at existing skill levels. Early identification of manpower, personnel, training, and safety (MPTS) high drivers, goals, constraints, and issues can provide positive design influences for new weapon systems if properly integrated into the acquisition and engineering process.

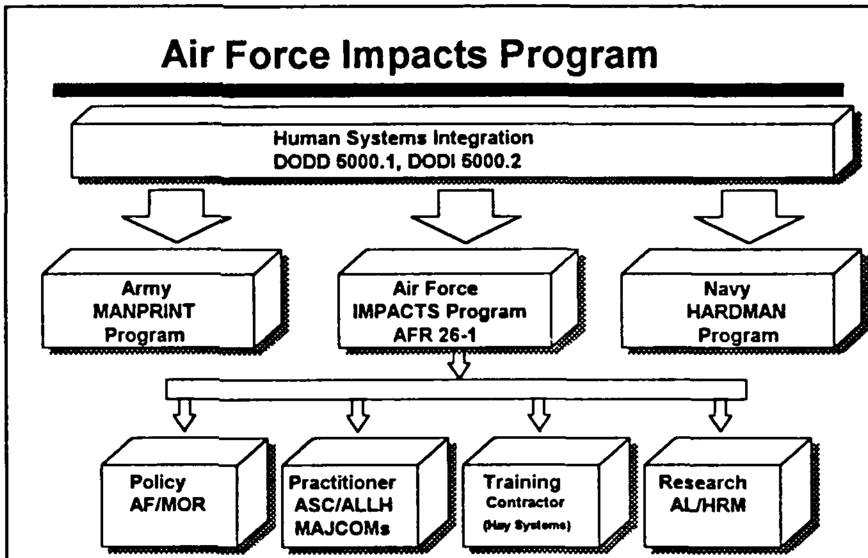


Figure 1 - Air Force IMPACTS Program

Congress and the Department of Defense recognized the need for better integration of the human during weapon system's acquisitions. Department of Defense Directive (DODD) 5000.1 and it's associated Instruction DODI 5000.2 have defined a Human Systems Integration Program [4]. The policies and procedures established in this instruction serve as the basis for integrating human factors engineering, manpower, personnel, training, health hazards, and safety considerations into the acquisition of defense systems. The policies set forth are "1) human considerations shall be effectively integrated into the design effort for defense systems to improve total system performance and reduce costs of ownership by focusing attention on the capabilities and limitations of the soldier, sailor, airman, or marine. 2) Objectives for the human element of the system shall be initially established at Milestone I, Concept Demonstration Approval, and be traceable to readiness, force structure, affordability, and wartime operational objectives. They shall be subsequently refined and updated at successive milestone decision points."

The U.S. Air Force's implementation of these procedures is embodied in the Integrated Manpower, Personnel, and Comprehensive Training, and Safety (IMPACTS) Program (AFR 26-1). Just as the Army's Manpower and Personnel Integration (MANPRINT) program and the Navy's Hardware versus Manpower (HARDMAN) integration program look at integrating soldiers and sailors into defense systems that are peculiar to those services, the IMPACTS program emphasizes integrating airman into air, space, and ground support defense systems within the Air Force organization. The IMPACTS program consists of a policy arm, trainers, practitioners, and continuing research (Figure 1) to improve IMPACTS processes and methods. This paper addresses the research arm of the IMPACTS program and describes an integrated analysis system now being developed. IMPACTS analysts and acquisition managers will use this analysis system to

ensure weapon system MPT costs are affordable, jobs are properly structured, and people are trained for their jobs prior to a new system becoming operational.

MPT Research Program

Manpower, personnel, and training (MPT) analysis evaluates human-in-loop costs and capabilities with intent to minimize MPT related LCCs while maximizing system capabilities. To clarify terminology, *manpower*, refers to the number of positions needed to operate, maintain, and support a system in its operational environment; *personnel*, to the types of people required and their characteristics and skills; and *training*, to what they need to know to do their job and what resources (trainers and training systems) will be required to achieve the desired skill proficiency. "This amounts to sizing (M), describing (P), and enabling (T) the work force so that it can accomplish a given workload or function effectively and economically" [5].

To provide the best new, or modified, weapon system at the least LCC, decision makers need up-to-date data and analysis tools. The first Air Force-wide MPT conference [6] held in May 1987 identified that a major problem within the acquisition community was (and continues to be) the lack of an integrated database and analysis methodologies to effectively analyze interrelated MPT issues. The Air Force Human Resources Laboratory (AFHRL — now Armstrong Laboratory, Human Resources Directorate) launched a comprehensive research program to meet the needs of System Program Office (SPO) decision makers in the acquisition process [7]. This program was designed to investigate data and data sources that could be used to support MPT analyses and began developing methods and tools in each of the functional domains to exploit the data. The objective was to develop a collection of methods and prototype tools that could eventually be integrated into a single integrated decision support system. The integrated system would enable acquisition and operational analysts to demonstrate the MPT related costs associated with various proposed weapon system designs, thus allowing design tradeoffs to reduce life-cycle costs.

The research culminated in the MPT Integration Branch awarding a four year, multimillion dollar advanced research and development (R&D) contract to provide acquisition decision makers with just such a DSS [8]. The contract to develop a Prototype Manpower, Personnel, and Training (MPT) in Acquisition Decision Support System (DSS) was awarded (Feb 92) to Dynamics Research Corporation and their subcontractors; Micro Analysis and Design, Rishi Technologies, and Organizational Research and Development. These companies have researchers who are intimately familiar with both the acquisition process and MPT issues and possess the needed knowledge and skilled staff capability to successfully develop an integrated system.

MPT in Acquisition DSS

This Advanced Technology Transition Development program will provide the first integrated tool for addressing MPT requirements during system acquisition and design. The MPT DSS is a micro-level (job task level) tool that will help analysts build a credible baseline of measurable MPT goals and constraints, provide MPT inputs needed for system tradeoff studies, allow analysts to study design alternative implications, and verify whether the completed system development achieved the MPT goals and constraints. The system will automate the extraction of historical MPT data from Air Force data bases and new system data from the Logistics Support Analysis Record (LSAR). This historical data will be used to create a baseline comparison system. As new system information is received, a

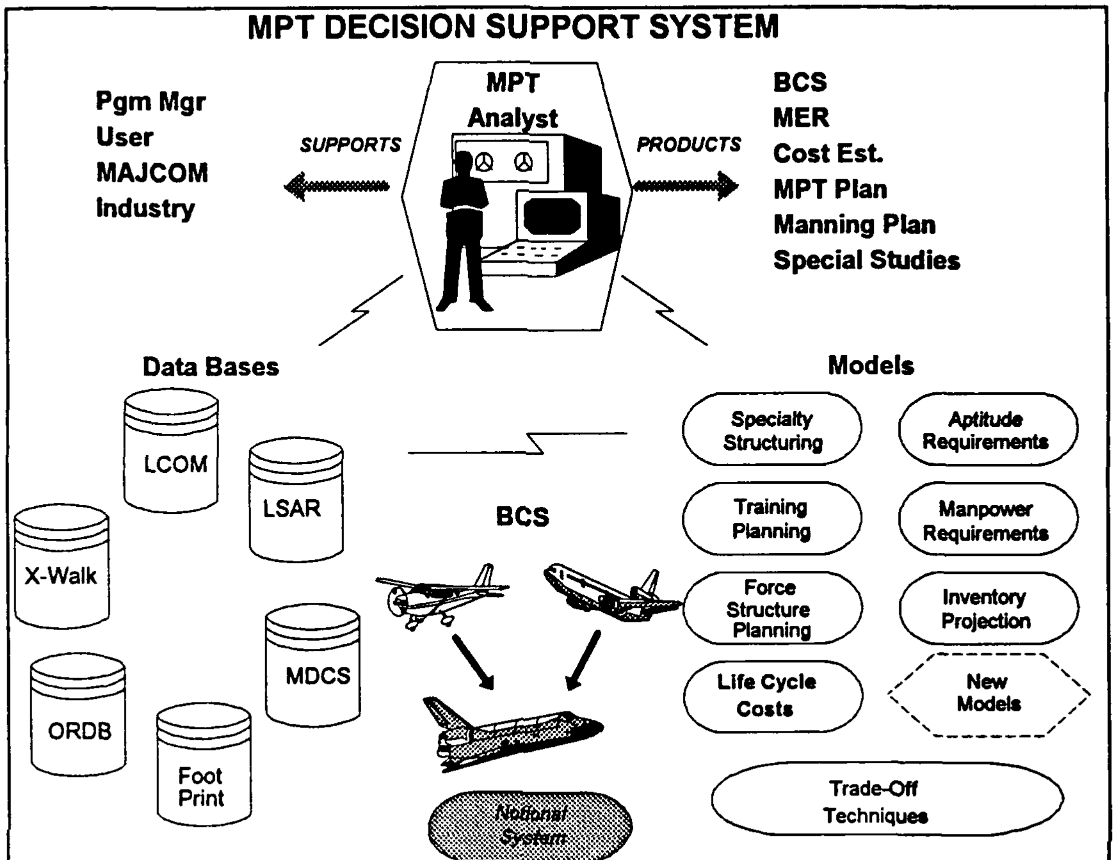


Figure 2 - Graphical View of MPT DSS

notional or proposed system configuration will emerge. Finally, a suite of MPT analysis methodologies and tradeoff tools applied to a baseline comparison system (BCS) and proposed system will produce key MPT products needed to support the acquisition and design process. The purpose of the MPT DSS is to reduce defense system's life-cycle costs while improving combat readiness and supportability by identifying and resolving MPT issues *early* in the acquisition of these systems.

The MPT DSS is graphically depicted in Figure 2. This illustrates the micro-level data bases and types of analysis techniques needed to provide a comprehensive, integrated tool. The MPT DSS will support all phases of the acquisition process, from requirements analysis and determination at the Air Force major commands (MAJCOMs) to design evaluation in the SPOs. Primary analysis goals are to validate that emerging weapon system designs meet MPT constraints imposed on that system and to provide personnel and training planners with information and decision processes to establish efficient training and personnel pipelines before weapon system delivery.

The MPT DSS is based on the results of a Manpower, Personnel, Training, and Safety (MPTS) factors in the system acquisition process study completed for the Human Systems Division (HSD) [9], a front end analysis of an MPT modeling architecture [10], and an evaluation of the Army's Hardware versus Manpower methodology (HARDMAN III) suite of MPT tools [11]. Continuing close coordination with Army HARDMAN experts is ensuring compatibility between the tools and avoiding duplication of effort.

The unique capability distinguishing the MPT DSS from Army and Navy HARDMAN research is that it is a cross-domain integrated system. The manpower, personnel, and training domains are interrelated. If an analyst makes changes in any one domain, these changes will most likely effect the other two domains. For example, if you reduce the number of people you plan to use to perform maintenance on a new fighter, you then have to expand the job definitions of the remaining people to cover those tasks that would have been performed by the manpower spaces that were eliminated. Once you have expanded the job descriptions for the remaining people, your training program becomes longer and more complex for both initial and recurring training. Unfortunately, the domains are managed separately, and the reality is that when changes are proposed within any one domain (e.g., the manpower community), those changes may be coordinated with the other domains (personnel and training) but there has been no mechanism available to study the long term impacts of these changes. The MPT DSS will include functional relationships within the integrated system tradeoff analysis methods to automatically reflect the horizontal cross-domain effects of making changes in one functional domain. This cross-domain capability will greatly enhance the ability to demonstrate the cost impacts associated with different policy decisions in any one single domain.

The prototype MPT DSS will focus on supporting the MPT analysis of Air Force aircraft systems but will be designed so that it can be applied to any type of system. Application to systems other than Air Force aircraft systems will require analysts to expand existing library files. The MPT DSS will concentrate on assessing MPT requirements for the maintainers and support personnel who work directly on the system in the operational units in which the weapon system will be fielded. More specifically, task-level MPT analyses will be conducted on maintainers and the support personnel whose workload is directly driven by the system. Operator crew size will be an input to the MPT DSS. Total manpower for operators, training personnel, and support personnel whose workload is not directly driven by the system will be determined by Air Force manpower standards that deal with aggregate workload, not individual tasks. The MPT DSS will contain both existing and new analytical tools.

The MPT DSS system consists of three major components: a System Development Subsystem (SDS), a Data Base Integration Subsystem, and the Analysis Tools Subsystem.

MPT DSS Software Components

When conducting an MPT analysis, selecting the BCS is a significant first step. The SDS will assist MPT analysts in constructing the BCS, populating the BCS task-level data bases with appropriate government and contractor-furnished data, and maintaining and updating the BCS data throughout the acquisition process. The SDS methodology includes techniques to match new system functional, performance, and design characteristics to those of existing Air Force equipment, at appropriate levels of system indenture.

An integrated MPT data base is needed to support the MPT DSS. The system must be capable of extracting and integrating MPT data from external Air Force data sources in a user-friendly manner. The Data Base Integration Subsystem will help Air Force MPT analysts obtain and use the input data needed for an MPT DSS application. The subsystem will request, extract, and process data from external sources; integrate input data within a comprehensive MPT DSS data architecture; and configure the data to support MPT analyses and tradeoffs.

The Analysis Tools Subsystem attempts to maximize the use of existing tools and techniques.

System Development Subsystem (SDS)

The SDS component consolidates MPT related predecessor weapon system data into a BCS. Then as design information matures, the BCS can be updated to form a proposed system description. The predecessor system is an existing system, or systems, that have components or missions similar to the new system concept. Descriptions of predecessor equipment, maintainers that repair it, manpower standards supporting it, and training courses related to it, provide a "footprint" for a new system. As identified in Logistics Support Analysis (LSA) Task 203 [12], a BCS is a representative system construct composed from existing systems/subsystems (predecessor systems), support systems, and lessons learned for performing comparability analysis. The BCS components should approximate one or more of the new system functional, performance, and design requirements. As the system matures and actual design data become available through the MIL-STD-1388-2B LSA Record (LSAR), they will replace the predecessor system data. This will permit continual improvement of system design information, and provide better predictions of Air Force MPT costs and support requirements.

Comparisons between the BCS and the proposed system are made throughout the acquisition process as the proposed system design evolves and design alternatives are considered. Comparison of the BCS to the proposed system requirements in the early phases of the acquisition process help identify areas of technical risk. Comparison of contractor design alternatives to the BCS in later phases also help identify risk areas (i.e., areas for which the contractor is proposing to deliver improvements that are significantly better than what is currently being achieved).

Data Base Integration

This component accomplishes two tasks: it links geographically separate data sources and relates data between dissimilar databases.

One of the most difficult problems for an MPT analyst is trying to obtain all of the unrelated data from locations around the country to support the integrated analyses. This burden will be reduced by introducing a system that will automate data retrieval from geographically separate data sources. The automated system will allow the user to check a block on the user screen identifying what data are required. Then, through overnight unattended file transfer over the Defense Data Network (DDN) or by modem connection for direct attended retrievals, the data will be electronically gathered to the analyst's machine.

Another major challenge is the process of relating weapon system specific data (weapon system specific job task lists) to occupational data (which Air Force Specialties (AFSs) accomplish those tasks). In the past, this process was accomplished by gathering a group of subject matter experts (SMEs) and having them laboriously relate the data. Earlier research [13] showed that we are able to automate the process through a semantic analysis process with about an 80 per cent text match. The SME time required is reduced by about two thirds.

This Database Integration Subsystem will provide the data needed for the BCS library and the suite of analysis tools. Maintenance, occupational, personnel, and logistic data from current systems will be used. Once predecessor systems are identified, the appropriate task-level data will be extracted. The Maintenance Data Collection System

(MDCS), Core Automated Maintenance System (CAMS), Logistic Composite Model (LCOM), Occupational Research Data Bank (ORDB), AFR 173-13 - Air Force Cost and Planning Factors, and Logistic Support Analysis Records (LSAR) files will be used. Such data bases will have their task-level data linked and extracted. If data for a specific sub-system are unavailable, then SMEs will be used. Part of this effort will require precise definitions of tasks and comparisons between the actual task statements.

Information about how to investigate the data that are available from various sources will be provided to the MPT analyst in the form of help screens. The generic content and structure of data within each source will be described including the level of equipment indenture for which data are usually available. For data sources hosted at a single, or a few geographic locations, the help screens will include contact points to whom data inquiries or requests may be directed.

Data Base Architecture - After task and MPT data are extracted from external sources, they must be incorporated into a common data architecture within the MPT DSS. The data architecture design will depend on the data meanings and relationships of the data extracted from the external source data bases. A different data element will be established in the MPT DSS data architecture for every unique data element "meaning" imported into the DSS. This will accommodate the several meanings expected for data elements such as task, failure rate, etc. If task means training task in one data base, maintenance task in another, and occupational survey task in still another, these tasks will be defined as separate data elements. The MPT DSS data architecture will incorporate standard MPT data elements defined by efforts such as the DoD Computer-aided Acquisition and Logistics Support (CALS) program.

The MPT DSS data architecture will ensure that relationships between data elements within a given source data base will be preserved within any data extracted from that source. This will provide the capability to effectively relate key MPT analysis findings and tradeoff results to the processes that generate the source data. For example, the LSA control number (LCN) and task code from the LSAR are not expected to be primary keys within the MPT DSS. However, by preserving the relationship of LSAR task data to their LCNs and task codes, any system design recommendations resulting from MPT DSS analyses and tradeoffs can be communicated to system designers and logisticians using familiar LCN/task code keys.

Analysis Tools Subsystem

This component is the core of the MPT DSS. Once the data are available, it must be analyzed and examined. The integrated set of analysis tools will be designed to support a step-wise process model for forecasting requirements based on best information available. This subsystem includes seven analysis methodologies, two tradeoff techniques, two analysis aids, and a planning aid.

The analysis tools include a <u>Specialty Structuring Tool</u> to structure jobs from the ground up, at the task or task cluster level or restructure a specialty starting from an existing definition; a <u>Personnel Aptitude and Characteristics model</u> to ensure that the collection of job tasks does not require unreasonably high aptitude levels or physical profile characteristics that can't be supported by the current or future Air Force population; a <u>Training Resources and Requirements Tool</u> to project an estimate of resources needed to establish and maintain the training pipeline; <u>Manpower Estimates Tool</u> to determine the number of people required to operate, maintain, support, and

train a single unit or squadron; a Force Structuring Tool to aggregate the manpower estimates into wings, groups, MAJCOMS, and force level projections using approved overhead and support ratios (sufficient to support manpower estimate reports required by DoD); an Inventory Projection/Civilian Availability Model to determine whether the civilian populace can support the level of aptitude in the numbers identified from the force projection model; finally, the last model is a LCC model that will present a bottom-line dollar figure to show the MPT related costs of the system.

The individual methodologies briefly described above are useful, but more important are the techniques to permit interaction among the individual tools to tradeoff the manpower, personnel, and training domains. There is a great deal of interaction between each of the domains. Significant changes cannot be made to any one functional domain without affecting the other two. Therefore, functional relationships will be included which describe, in analytic terms, the relations between the various M and P and T factors. MPT measures of effectiveness (MOEs) will be used by the tradeoff process to provide objective criteria - identifiable and explicit- for evaluating MPT impacts of design, operation, and support alternatives. MPT control variables (i.e., the variables that the MPT community controls, and can change, to accommodate a new system) will be identified for each MPT MOE. In conducting tradeoffs, the control variables can be viewed as input variables and the MPT MOEs can be viewed as the outcome variables that are used to assess MPT impacts for all types of tradeoffs (design, support, operations). An MPT Analysis Tradeoff Aid will identify BCS or proposed system high (cost) drivers from the MOEs. Using these high drivers, an analyst can begin conducting a sensitivity analysis by adjusting the control variables contributing to the MOE identified as a high driver. The MPT Analysis Aid will empower the analyst to conduct tradeoffs in an accelerated mode where only one variable has been changed and the entire analysis (including manpower simulation) will be rerun, or in detailed mode where the analyst can make multiple changes in several different tools. The second tradeoff technique is a Comparison Tool that will let an analyst display side-by-side results of different completed studies. The Comparison Tool uses summary reports and graphics to compare differences between the system, type, and versions. The *system* refers to the type of proposed system you are analyzing, *type* refers to the type of analysis you are conducting, and *version* refers to the specific analysis conducted. By varying the control parameters you create multiple versions of the analysis. The comparison tool allows you to compare these individual versions. These comparisons can demonstrate the relative value of different MPT approaches allowing policy options or system design differences to be studied. An analyst can converge on an optimal solution before beginning the full documentation needed to complete a study in support of required acquisition documentation.

The analysis aids are tools that will improve the IMPACTS analyst's ability to use the DSS. An integral Navigation Aid assists the user in correctly using the integrated analysis methodology for different types of studies. This technique consists of both a navigation aid visually depicting the steps necessary to complete a particular type of analysis and an extensive Context-Sensitive Help component providing detailed topic-related assistance throughout all stages of the analysis.

The planning aid, the MPT Pipeline Tool, will assist Air Force analysts in scheduling the MPT resources associated with deploying new systems. The pipeline tool will consider training, organizational, and support pipelines, to ensure plans are developed to have trained people where and

when they are needed to achieve full operational capability. Outputs from this tool include a master milestone chart that will be a PERT/CPM chart illustrating the time phasing of key MPT resourcing events based on the proposed acquisition strategy. The tool will also provide system training plan information and a forecast of required permanent change of station moves.

Key MPT-related Acquisition Products and Processes

Products of the MPT DSS include the Manpower Estimate Report; Comparative Analysis (LSA task 203); support for LSA tasks 303 - Evaluation of Alternatives and Tradeoff Analysis, 401 - Task Analysis, and 402 - Early Fielding Analysis. The MPT portions of a Cost and Operational Effectiveness Analysis (COEA) can be prepared or validated. Finally, the DSS will produce analysis summaries and Human Systems Integration plans in a format needed for the IMPACTS plan and Integrated Program Summary

MPT DSS Payoffs

The integrated analysis tool and decision support system will assist acquisition managers, analysts, and MAJCOM planners to effectively integrate people issues (numbers, characteristics, proficiency) with equipment (aircraft) early in the acquisition cycle. Acquisition specialists can use the structured analysis approach provided by the MPT DSS to ensure that system people costs are affordable, jobs are properly structured, and people are trained prior to the system becoming operational. The analysis methodology includes cross-domain effects of different weapon system designs, logistics concepts, or occupational and organizational structures. Different policy decisions can be modeled and the cost impact of those decisions identified.

Program Test and Evaluation

The final program phase will be a comprehensive test and evaluation of the whole prototype system. Development of the MPT DSS will involve a prototype demonstration of a specific weapon system. This will permit the incorporating actual data and requirements in the MPT DSS and identifying issues for resolution. A rigorous test of the final integrated MPT DSS prototype will be conducted under stringent standards using still another weapon system with intent to validate the overall process model. Close cooperation with the SPO and the manpower, personnel, training and using communities, especially MPT planning teams, will be a key part of the DSS development and validation. Incremental delivery of the MPT DSS is planned as each subsystem is completed.

Hardware and Software

The system will operate on an 80486 class (or better) microcomputer in a Microsoft Windows environment. Anticipated hardware requirements include 1 GB of data storage and 16 MB of RAM. The software will be written in the C++ programming language and follow object oriented design constructs. There will be full documentation of the entire system, including user's manuals, design documents, technical reports, and detailed system and software specifications.

Summary

The MPT DSS is intended to help MAJCOM requirements planners and SPO analysts and decision makers insert MPT factors into the acquisition process. It will provide, in one integrated system, a means of accessing task-level data, analyzing it, and presenting it for review and study at any milestone in the acquisition process. This type of tool has long been needed by the MPT community and SPO decision makers.

References

[1] Yates, R.W. (1989). The USAF IMPACTS Program. Air Force Principal Deputy, Assistant Secretary (Acquisition) Letter, dtd 7 April 1989.

[2] Oliveri, F. (1992). Aerospace World: GAO Hits Night Attack Plans & Airlift Questions Raised. Air Force Magazine. Volume 75, No. 8, Aug 1992., 18-19.

[3] Cole, F.A. (1991). The Impact of Manpower, Personnel, and Training (MPT) on Life Cycle Cost. Proceedings of the IEEE 1991 National Aerospace and Electronics Conference (NAECON 1991). Volume 2, 842-848. IEEE Catalog No. 91CH3007-2.

[4] Department of Defense Instruction 5000.2, Defense Acquisition Management Policies and Procedures. Part 6 Section H, Human Factors, 6-H-1 - 6-H-3. Part 7 Section B, Human Systems Integration, 7-B-1 - 7-B-5. 23 Feb 91.

[5] Boyle, E. (1992). MPT Briefly. IMPACTS Bulletin. HQ USAF/MOR, Washington, DC: Vol IV, No. 1, Jan-Feb 92, 1-3, 8-10.

[6] Longmire, K.M., & Menchaca, J., Jr. (Eds.) (1987). Proceedings of the AFHRL MPT Conference. Brooks AFB, TX: Air Force Human Resources Laboratory.

[7] Bergquist, T.M. (1991). Air Force Manpower, Personnel, and Training (MPT) in Systems Acquisition Research Program. (AL-TP-1991-0021). Brooks AFB, TX: Manpower and Personnel Division, Human Resources Directorate, Armstrong Laboratory.

[8] Bergquist, T.M. (1990). Development of an MPT Decision Support System (DSS). IMPACTS Bulletin. HQ USAF/PRQE, Washington, DC: Vol III, No. 6, Nov-Dec 90, 1-3.

[9] Rosmeissl, P., Akman, A., Kerchner, R., Faucheux, G., Wright, E., Shields, J., & Waldrop, G. (1990). Analysis of Manpower, Personnel, Training, and Safety During the Acquisition of Air Force Systems: Requirements and Capabilities (three volumes) (HSD-TP-90-022). Brooks AFB, TX: Deputy for Development Planning, Human Systems Division.

[10] Rue, R.C, Black, M., Rose, D., & Bartenwerfer, D. (1991 March). Air Force Conceptual Weapon System Optimization Model (AL-TR-91-573-0202). Brooks AFB, TX: Manpower and Personnel Division, Human Resources Directorate, Armstrong Laboratory.

[11] Kaplan, J.D. (1991 January). "Synthesizing the Effects of Manpower, Personnel, Training, and Human Engineering" in Boyle, E., Easterly, J., Ianni, J., Karma, M., & Harper, S. (Eds.) Human-Centered Technology for Maintainability: Workshop Proceedings. Wright-Patterson AFB, OH: Logistics and Human Factors Division, Human Resources Directorate, Armstrong Laboratory, 275-285.

[12] Air Force Logistics Command Pamphlet 800-17, Air Force Logistics Support Analysis Primer. 20 May 1988, 13.

[13] Driskill, W.E., Weissmuller, J., Hageman, D. (1992, in press). Initial Procedures for Providing Weapon System-Specific Data. Draft Technical Publication, Brooks AFB, TX: Manpower and Personnel Research Division, Human Resources Directorate, Armstrong Laboratory.

The Advanced Assault Amphibian Vehicle (AAAV) Training System Plan: Blueprint for a Successful Training Acquisition

Lt.Col James Feigley
U.S. Marine Corps
and
Dr. David J. Daly, Dr. Charles A. Beagles
Naval Training Systems Center

ABSTRACT

The planning for training systems has gained increased emphasis in the Department of Defense (DoD) community as training devices have become more complicated and expensive. DoD Instruction (DoDI) 5000.2, "Defense Acquisition Management Policies and Procedures" dated February 23, 1991, directs the evolution of a "training system" concept concurrently with the development of new weapon systems. *Draft* DoD Directive 1430.13, Development and Life-Cycle Management of Military Training Systems, directs a structured approach in this training system concept formulation. The directive requires that the developing agency thoroughly analyze the intended use, affordability, and effectiveness of the new training concept. To acquire a training system in this framework of a systematic training analysis process, DoDD 1430.13 requires that associated hardware, courseware, and implementing personnel be studied in the context of an economic analysis, cost effectiveness analysis, and training effectiveness analysis.

In the implementation of the Advanced Assault Amphibian Vehicle (AAAV) Training System Plan as directed by DoDI 5000.2, Marine Corps planners will be customizing the requirements of MIL-STD-1379D, Military Training Programs, under the framework of OPNAVINST 1500.59, Surface Warfare Training System Acquisition Process and Responsibilities. Program planners have found that by combining these two training and acquisition oriented approaches, a thorough "training systems" approach emerges which is fully consistent with the intent of DODI 5000.2. This paper outlines the approach with the intent that it can benefit the planning of other military program managers.

INTRODUCTION

To date, the planning for major military training procurements has of necessity been driven by the engineering hardware complexity and the dollar value of the procurement. For instance, in the procurement of a complex weapon systems trainer, Marine Corps program managers have been able to utilize OPNAVINST 1500.59, Surface Warfare Training System Acquisition Process and Responsibilities, to organize and schedule associated engineering, fiscal, logistics, and manpower requirements. However, when the training procurement was geared to a classroom "training system" such as computer-based instruction (CBI), interactive video disc (IVD), or interactive courseware (ICW), the acquisition was driven more by courseware and training issues. In the latter case, MIL-STD-1379, Military Training Programs, has emphasized such training issues as training situation analysis, lesson specification development, and training evaluation. The strength of the hardware acquisition driven approach is a thorough definition of the engineering complexity and logistics of the required training hardware. The strength of the training analysis and courseware driven approach is a thorough definition of the training requirement and "intended use" by the school or training command.

TRAINING SYSTEM DEVELOPMENT APPROACH

This plan was developed after a review of training systems developed within the Marine Corps and the Navy. Since the Advanced Assault Amphibian Vehicle (AAAV) will be a new weapon system, it was assumed that the new training system should build upon the strengths of both Marine Corps and Navy training practices. Past training program "lessons learned" were factored into the proposed training development approach. The Navy HARDMAN Process has been utilized as a major planning tool as well as the planned development of a AAAV Marine Corps Training Plan (MCTP). This training system plan will outline the activities necessary to build the AAAV training system. The AAAV MCTP will identify those activities necessary to ensure the ongoing management of the AAAV training system.

Overview. As the AAAV weapon system design matures during the early acquisition phases, more and more detail on training system requirements will become available. The training system program goal is to use weapon system design information early enough in the development process to ensure the deployment of the AAAV training system before the deployment of the weapon system. A listing of the tasks identified by MIL-STD-1379D for the systematic development of training programs is presented in Table 1.

The MIL-STD-1379D *training and courseware oriented development tasks* are identified by their requirments for each weapon system phase in Figure 1. Figure 1 also presents training *hardware oriented acquisition tasks* (ie., OPNAVINST 1500.59. guidance) for each weapon system phase. The guidance from these two documents (MIL-STD-1379D & OPNAVINST 1500.59) has been integrated as the basis for this AAAV Training System Plan. The following sections of this plan will describe the proposed AAAV training system development approach.

TASK SECTION 100. TRAINING PROGRAM MANAGEMENT

Task 101: Training Situation Analysis
Task 102: Training Program Development & Management Planning
Task 103: Training Development Control
Task 104: Training Development Requirments Identification
Task 105: Training Implementation Planning
Task 106: Training Implementation Control
Task 107: Training System Support Materials

TASK SECTION 200: TRAINING PROGRAM ANALYSIS AND DESIGN

Task 201: Mission, Collective, Individual & Occupational Training Task Analysis
Task 202: Training Technology Assessment
Task 203: Learning Analysis
Task 204: Media Selection
Taks 205: Tests for Measurement of Personnel Achievement
Task 206: Training System Alternatives Identification
Task 207: Training System Modification Requirements
Task 208: Training System Functional Requirments
Task 209: Training System Facilities Requirments Identification
Task 210: Lesson Specification Development
Task 211: Instructional Media Design

TASK SECTION 300: TRAINING MATERIALS DEVELOPMENT

Task 301: Instructional Media Production
Task 302: Training System Support Materials
Task 303: Training Materials for Instructors
Task 304: Training Materials for Trainees

TASK SECTION 400: TRAINING SUPPORT, CONDUCT AND ADVISORY SERVICES

Task 401: Conduct of Training
Task 402: Training Evaluation

Table 1. Requirements for Military Training Programs (MIL-STD-1379D)

Figure 1. Training System Acquisition Requirements by Phase

	CONCEPT EXPLORATION	DEMONSTRATION/VALIDATION		FULL SCALE DEVELOPMENT	PRODUCTION	DEPLOYMENT
MILITARY TRAINING PROGRAMS MIL-STD-1379D	MANAGEMENT	ANALYSIS & DESIGN		DESIGN & DEVELOP	DEVELOP & TEST	EVALUATE
	TASK 101	TASK 102 TASK 103	TASK 104	TASK 105	TASK 106 TASK 107	
		TASK 201 TASK 202 TASK 203 TASK 204	TASK 206 TASK 207 TASK 208 TASK 209	TASK 210 TASK 211 TASK 301	TASK 302	TASK 402
				TASK 205	TASK 303 TASK 304 TASK 401	
TRAINING SYSTEM ACQUISITION OPNAVINST 1500.59	HARDMAN	UPDATE HARDMAN		MAINTENANCE CONCEPT	TRAINING FACILITY COMPLETED	CONFIGURATION MGMT
		AAAV MARINE CORPS TRAINING PLAN (MCTP)		LOGISTICS CONCEPT	TRAINING SYSTEM DELIVERED	
		DEVICE(S) MILITARY CHARACTERISTICS (MCs)		UPDATE MCTP	READY FOR TRAINING (RFT)	
		ACQUISITION PLANS		MILCON INITIATED	TRAINING PIPELINE INPLACE	
		MILCON PLANS		TRAINING ACQUISITION EXECUTED	MAINTENANCE & LOGISTICS CONCEPTS IMPLEMENTED	
		POM SUBMITTALS				

Development Approach. Training program tasks identified by 1379D will be selectively applied for the AAAV Training System as the AAAV weapon system evolves. These training program tasks will be implemented within the context of the training system planning and acquisition requirements of OPNAVINST 1500.59. The tasks will be tailored during each weapon system phase depending on the emerging training needs of the program.

CONCEPT EXPLORATION PHASE REQUIRMENTS

HARDMAN Analysis. HARDMAN analysis has been conducted to establish baseline projections for AAAV manpower, personnel, and training (MPT) requirements. Several training situation analyses, Task 101, were completed during the preconcept phase as input to the HARDMAN analysis. The following three reports were required from each industry contractor conducting the AAAV concept design study: HARDMAN Assessment Report; Manpower, Personnel, and Training Concept Document (MPTCD); and Manpower, Personnel, and Training Resource Requirements Document (MPTRRD).

The baseline projection will be updated during the demonstration/validation phase as the AAAV design evolves. Based on the initial HARDMAN analysis, the following requirements have been identified as key areas for AAAV training: crew operations/crew coordination, driver operations, navigation, communication, emergency egress, turret operations, weapons training, maintenance training, emergency maintenance procedures, mission planning, tactics, and crew/infantry coordination.

DEMONSTRATION/VALIDATION PHASE REQUIRMENTS

HARDMAN Update. The AAAV MPT requirements analysis will be updated as the weapon system design evolves. An initial estimate of manpower (IEM) will be developed. The IEM will include an updated projection of the manpower required to operate, maintain, and support the weapon system. The HARDMAN analysis will also update training system requirements. Training and training device requirements will be updated. A training situation analysis will also update the organizational requirements at the unit and institutional levels.

By the middle of the demonstration/validation phase, the weapon system design will have evolved from subsystem to equipment to component specification. One or several AAAV prototypes will be developed. Based on this increased level of detail, an updated operator and maintainer task analysis (ie., Task 201) will be developed. The embedded training and built-in-test capabilities of the weapon system will be completely specified. As more design detail becomes available, the AAAV MPT projections will be iteratively updated.

Marine Corps Training Plan (MCTP). The updated HARDMAN analysis will be used as a basis for (a) the development of the Marine Corps equivalent of a Navy Training Plan (NTP), and (b) the implementation of training program development activities specified by MIL-STD-1379. The MCTP will become the primary document for defining Manpower, Personnel, and Training (MPT) requirements for the AAAV including the resources (billets, training devices, training equipment, training courses and military construction) necessary to support the weapon system's introduction to the Marine Corps. The selection of MIL-STD-1379 training program tasks will ensure that the training system (courseware and devices) is developed and planned to systematically fit the requirements and constraints of associated schools, units, and shipboard detachments.

Military Characteristics (MCs). Military Characteristics (MCs) for training devices will be developed as a byproduct of MIL-STD-1379 Task 208, Training System

Functional Requirments. The MCs will document operational and performance requirements as a basis for developing training devices. The MCs will be used key documents for program management review and as source documentation for the acquisition of the AAAV training system.

Training System Acquisition Plan. As the scope of the training system is specified through the training front end analysis, acquisition strategies for the training system will be developed and finalized. During the demonstration/validation phase, a Draft Training System Acquisition Plan will be developed by the Naval Training Systems Center for review by the DRPM AAA. The training system development will be separate from the weapon system development. The Naval Training Systems Center has been designated the principle development activity (PDA) for the AAAV Training System. Acquisition approaches will address alternative strategies for the development of training devices, courseware, classroom instructional media, and mockups.

MILCON Plans/Submittals. Based on the training device requirements specified by the MCs, site surveys from the preconcept phase training situation analyses will be updated. A Training Equipment Facilities Requirements (EFR) Plan will be developed six years prior to the ready-for-training (RFT) date. The EFR plan is the basis for the Training System Military Construction (MILCON) submittal. Military construction (MILCON) plans will be coordinated and the requisite documentation will be submitted based on the Training System EFR Plan.

POM Submittals. Program and budget resources will be planned for the acquisition and life cycle support of the training system. POM submittals will be programmed annually based on requirements identified in the annual MCTP review.

FULL SCALE DEVELOPMENT PHASE REQUIRMENTS

Maintenance & Logistics Concepts. Maintenance & logistics concepts will be developed for the maintenance and sparring of training devices and the update of curricula, courseware, and training devices. An ILS program will be developed for the training system to achieve the system readiness objectives at an affordable life cycle cost. Early ILS program activity will focus on designing affordable support characteristics into the training system. Subsequent activity will focus on acquisition, evaluation and deployment of support resources. The training system will be included in the Naval Training Systems Center's COG "2" 0 life cycle management program.

Marine Corps Training Plan (MCTP) Update. During full scale development, the MCTP will be updated in coordination completion of MIL-STD-1379 Task 105, Training Implementation Planning. Institutional, unit, and onboard training plans will be more detailed given the completion of the initial design analysis.

Training System Military Construction (MILCON) Initiated. Based on the Training Equipment Facilities Requirements (EFR) Plan developed in the previous phase the military construction (MILCON) for training facilities will be initiated. The implementation will ensure that the facilities will be available before delivery of the training system.

Training System Acquisition Executed. Based on the acquisition planning from the previous phase, the training system (training devices, training media, and courseware) procurement/s will be initiated. The procurement of the training system will have the same emphasis as the procurement of the AAAV to ensure that the training system delivery precedes the delivery of the weapon system.

PRODUCTION PHASE REQUIRMENTS

Training Facility Completed. The training facilitymodifications and/or construction will be completed with appropriate space for classroom, laboratory, and training device activities. If appropriate, the coordination of satellite hookups between units will be established for battalion level distributed training.

Training System Developed. The training system development and implementation will be guided by MIL-STD-1379 Task 106, Training Implementation Control, and also by Task 107, Training Evaluation Planning. A training effectiveness evaluation plan (TEEP) will be developed to measure the performance specified by the initial task analysis conducted during demonstration/validation.

Ready For Training (RFT). Acceptance tests will be conducted on the training system in advance of the RFT date specified by the Marine Corps.

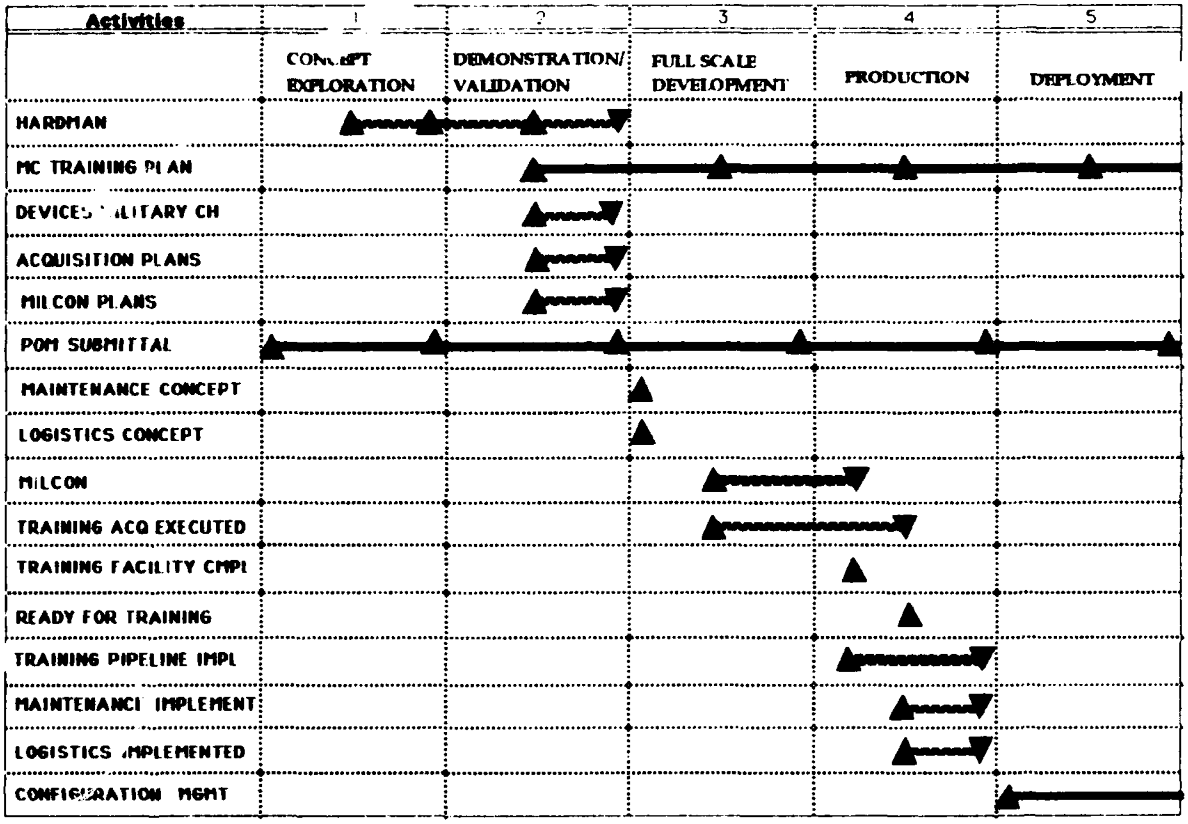
Maintenance/Logistics Concepts Implemented. All preparations and contracting for the life-cycle support of the training system will be concluded prior to the RFT date. The support of the training system will be initiated concurrently with the initiation of training.

DEPLOYMENT PHASE REQUIRMENTS

Configuration Management. Configuration management of the training system will be built into the POM process so that the training system reflects the evolving modifications of the weapon system. Training system updates will be incorporated through the yearly review and revisions of the AAAV Marine Corps Training Plan.

AAAV Training System Milestones. Figure 2 presents the training system schedule and milestones.

FIGURE 2. AAAV TRAINING SYSTEM MILESTONES



SUMMARY AND CONCLUSIONS

Currently the design of the Advanced Assault Amphibian is in its early stages and training concepts are evolving with the competing design concepts. DoD emphasis on training in distributed simulated environments will add to the complexity of the training analysis. There will be a need to understand hardware technology issues such as interconection requirments, standards, and protocols. In addition, there will be a need to fully analyze the breadth and depth of the individual and collective training requirment as well as proper feedback and evaluative techniques to ensure training with the minimum of training management resource penalties. This training system plan is comprehensive enough to address the planning and analysis requirments for future training hardware and courseware mixes. The plan also permits the program manager the flexability to focus and refine analayses as the training system requirments become more concrete as the weapon system design evolves.

ABOUT THE AUTHORS

LTCOL JAMES M. FEIGLEY is currently the Assistant Direct Reporting Program Manager for the Advanced Amphibious Assault (AAA) Program. He has served as a platoon and company commander and battalion operations officer in the 1st Amphibian Tractor Battalion, 2nd Assault Amphibian Battalion, and 1st Tracked Vehicle Battalion. He is a graduate of the Amphibious Warfare School; Marine Corps Command and Staff College; Project Managers Course, Army Logistics Management Center, Fort Lee, Virginia; and the Program Managers Course, Defense Systems Management College, Fort Belvoir, Virginia.

DR. DAVID J. DALY is managing the Advanced Amphibious Assault HARDMAN Analysis. He has most recently been involved in industry with weapon system developments integrating economic, logistics, and HARDMAN analyses. He holds a Ph.D. degree from Indiana University in instructional systems technology.

DR. CHARLES A. BEAGLES is Deputy Program Director for Marine Corps Programs, Naval Training Systems Center (NTSC). He has worked in training analysis and design since 1976. Prior to joining NTSC, he worked at the Center for Needs Assessment and Planning, Florida State University. Dr. Beagles is a former Marine Corps Captain and served as a Rifle Company Commander in Vietnam. He holds a Ph.D. degree from Florida State University in educational psychology.

EVOLVING CRITERIA FOR EVALUATION: THE CHALLENGE FOR THE INTERNATIONAL INTEGRATOR OF THE 90s.

Joan Fowler & Virgil Gibson
Security Architects
Grumman Data Systems

Abstract

This paper presents a comparison of three international security criteria and contrasts their approaches. It demonstrates the integrator's perspective of the implications for designing solutions to meet worldwide information protection needs. The implied and stated use of each of the criteria is included in this paper with a description of the barriers to understanding between the criteria. A high level comparison of the approaches taken in the three criteria is presented. From the system integrator's perspective, the causes for the ambiguity between these criteria are discussed, with suggestions for the international community.

Introduction

The United States (U.S.) Department of Defense (DoD) published in 1985 the DoD Trusted Computer System Evaluation Criteria (TCSEC) [3] which is the seminal work in detailing the criteria which guide buyers and sellers in the computer security arena. The TCSEC, and its interpretations; the Trusted Network Interpretations (TNI) [7], the Trusted Database Interpretation (TDI) [8], and the Computer Security Subsystem Interpretation (CSSI) [9], form the nucleus around which the U.S. Trusted Product Evaluation Program has developed.

Recently, two new criteria have appeared on the world scene which are to be used in the evaluation of security applications of computer technology. In December 1990, the Canadian System Security Centre (CSSC) released the Canadian Trusted Computer Product Evaluation Criteria (CTCPEC), Version 2.0. The CTCPEC was revised in April, 1992, as Version 3.0. [2] In June 1991, the Harmonized Criteria of France, Germany, The Netherlands and the United Kingdom (UK) was published as the Information Technology Security Evaluation Criteria (ITSEC), Version 1.2 [5].

This paper is divided into two overall segments. The first segment is a description of the three criteria: their intended audiences, life cycle use, and approaches. The second segment describes how the international systems integrator is involved in the situation. This second segment also provides the system integrator's perspective of the first segment: the ambiguities caused by the three international criteria, and suggestions for the future.

Stated or Implied Use of Each Criteria

Before discussing the intended use of each of the criteria, the definition of a couple of terms is in order. For the purposes of this paper, a product "is a hardware and/or software package that can be bought off the shelf and incorporated into a variety of systems." A system "is a specific [data processing] installation with a particular purpose and known operational environment" [5].

Intended Audience for the Criteria

All three of the criteria have a common understanding of these two terms, product and system. However, the three criteria are not intended to be used in the same context with regard to the two terms.

The target for evaluations using the U.S. TCSEC has historically been primarily products. Its focus is on industry, in that it is an incentive to vendors to develop trusted products. An entire series of guidelines have been developed to aid industry in the use of the criteria. The TCSEC is intended to provide guidance to the commercial world on the development of trusted products, and provide a direction for the growth of each individual product. Industry may choose to grow their product toward more security features or more assurance in these features.

The Canadian CTCPEC specifically states that the target for its evaluation is products. However, the focus of the CTCPEC is on government. The criteria does not provide clear direction for the growth of commercial products. It

provides only the criteria by which a product may be *evaluated once* it is developed. However, the CTCPEC very conveniently allows a vendor to develop a product, and then add to the assurances of the product by improving the documentation in a growth fashion.

The European ITSEC specifically maintains that its target for evaluation is both products and systems. The ITSEC states that "it is important for the sake of consistency that the same security criteria are used for both products and systems; it will then be both easier and cheaper to evaluate systems containing products which have already been successfully evaluated." [5] Because of the loose nature of the ITSEC approach, it also does not present a clear growth direction for the security features of products. However, like the CTCPEC, vendors may build a product/system and then add to the assurances of the product/system by improving the documentation and receiving a higher rating for assurance.

Barriers to Understanding

There are further barriers to understanding of the three criteria. The use of terminology in the three criteria is one of these barriers. Certain actions in the overall evaluation process are not universally identified in the three schemes. To illustrate this point, a simile of the process by which a household appliance receives the Underwriters Laboratories (UL) Seal of Approval will be used. The appliance is developed by a vendor and submitted to UL for testing. UL initially may test the appliance in a laboratory. This is the same as the evaluators scrutinizing a product "from a perspective that excludes consideration of a specific application environment." [2] In the U.S. and Canada, this process is referred to as the Evaluation performed by the National Computer Security Center (NCSC) and the CSSC respectively. However, since the ITSEC is aimed at both products and systems, there is not a clear distinction between this first type of evaluation and those performed for specific application environments.

Returning to the simile, once the UL has tested an appliance in the laboratory, it may be tested for application to some specific representative types of households. This is similar to the "assessment to determine whether appropriate security measures have been taken to permit the system to be used operationally in a specific environment." [3] This second type of evaluation is called the Certification evaluation under the TCSEC. In the CTCPEC, the exact same type of evaluation is termed a Risk Assessment. Again, since the ITSEC does not differentiate between its use for systems and products, it only recognizes the single type of evaluation.

The final step in the process of the appliance testing is the award of the UL Seal of Approval. This is awarded after the evaluation; and an official authorization is given that the appliance meets the standards for the Seal of Approval. In the TCSEC, the "official authorization that is granted to an [Automatic Data Processing] ADP system to process sensitive information in its operational environment" [3] is the formal approval/accreditation procedure, usually referred to as an accreditation. The CTCPEC refers to the same procedure as the formal approval. The ITSEC indicates that national certification bodies "will award certificates to confirm the rating of the security." [5] In the ITSEC, the process to award these certificates is referred to as the certification process.

This simile of household appliance UL testing demonstrates that terminology is a confusion factor for the systems integrator using all or a combination of the three criteria. Since evaluation, risk assessment, certification, final approval, and accreditation can mean different processes within the approval of systems and products, the integrator must be aware of the criteria and audience when using each of these terms.

Life Cycle Use of the Criteria

At the current time, the practical use of the TCSEC is much more specified than that of the other two criteria. Since the TCSEC has been available longer, this situation is not surprising. The NCSC has developed guidelines for vendors on the use of the TCSEC for product evaluation and evaluation maintenance: the Trusted Product Evaluations, A Guide for Vendors [10]; and the Rating Maintenance Phase, Program Document [11]. The first describes the procedure which the vendor should use to take a product through evaluation, and the second defines the procedure to reevaluate subsequent releases of evaluated products.

Neither the CTCPEC nor the TCSEC discuss the practical use of the criteria. The ITSEC

acknowledges that there needs to be national certification bodies to perform evaluations and a national procedure for the maintenance of certified ratings following changes to an evaluated target. However, the details of both of these procedures are indicated as being beyond the scope of the ITSEC. Last spring the Information Technology Security Evaluation Manual (ITSEM) was released for comments in draft version 0.2. [6] This document is meant to "harmonize existing security evaluation methods in each of the four countries in order to ensure that national evaluation methods conform to a single philosophy". This recent development is a major step toward standardization of the use of the ITSEC. The latest version of the CTCPEC indicates that it was written in such a way to preclude the need for interpretations. However, only practice will determine the procedures for the use of that criteria.

Approach Comparison

The schemes defined in each of the criteria are different in some ways, and the same in others. However, the underlying principle is common to the three criteria. This underlying principle is that there are security features (e.g., access control, auditing) which are required to be available in products/systems. Additionally, there are assurances (e.g., documentation, testing) which must be used to prove that the features are performing completely, correctly, and consistently. All three of the criteria agree on these concepts. However, the packaging of these concepts and some of the details of implementation of these principles are drastically different. The similarities and differences are addressed here to highlight the differences which will cause a barrier to international acceptance of products/systems and illustrate the knowledge which an international integrator needs to compete.

The U.S. TCSEC Approach

The TCSEC has specified the set of functional features and a set of the type of associated assurances which a product must possess for each class level. These features and assurances are bundled together into a single class. There are four possible divisions containing seven classes in the TCSEC scheme. These divisions are Minimal Protection (D), Discretionary Protection (C1 and C2), Mandatory Protection (B1, B2, and B3), and Verified Protection (A1). A target (product) must meet all of the requirements of a class to be assigned the class level. If one of the functions or assurances of a particular class is not available for the target, the next lower class level with which the target complies is assigned to the target.

The Canadian CTCPEC Approach

The CTCPEC scheme is separated into criteria of security functionality features and assurances. Unlike the TCSEC, the functional features are not grouped together with the assurance requirements. There are five criteria: Confidentiality, Integrity, Availability, Accountability, and Assurance. Each criteria is further divided into divisions and levels. The Confidentiality criteria is decomposed into: covert channels (CC-0, CC-1, CC-2, and CC-3); discretionary confidentiality (CD-0, CD-1, CD-2, CD-3, and CD-4); mandatory confidentiality (CM-0, CM-1, CM-2, CM-3, and CM-4); and object reuse (CR-0 and CR-1). The Integrity criteria is divided into: discretionary integrity (ID-0, ID-1, ID-2, ID-3, and ID-4); mandatory integrity (IM-0, IM-1, IM-2, IM-3, and IM-4); physical integrity (IP-0, IP-1, IP-2, IP-3, and IP-4); rollback (IR-0, IR-1, and IR-2); separation of duties (IS-0, IS-1, IS-2, and IS-3) and self testing (IT-0, IT-1, IT-2, and IT-3). The Availability criteria is divided into: containment (AC-0, AC-1, AC-2, and AC-3); robustness (AR-0, AR-1, AR-2, and AR-3); and recovery (AY-0, AY-1, AY-2, and AY-3). The Accountability criteria is partitioned into: identification and authentication (WI-0, WI-1, and WI-2); audit (WA-0, WA-1, WA-2, WA-3, and WA-4); and trusted path (WT-0, WT-1, and WT-2). Finally, the Assurance criteria consists of trust (T-0, T-1, T-2, T-3, T-4, T-5, T-6, and T-7). Tables 1 through 4 illustrates the CTCPEC profiles which correspond to the TCSEC Classes C2 through B3 respectively. There is no correlation to these profiles and the associated levels of trust within the corresponding TCSEC Classes. An equivalent TCSEC profile does not imply that a TCSEC rating meets the profile. Hence, these are to be considered as one way mappings.

As in the TCSEC, a target (product) must meet all of the requirements for a specific level, otherwise it is assigned the lowest class with which the target complies completely. Each criteria division contains a level designated "0". This level is reserved to targets which have been evaluated but failed to meet the requirements of any of the higher levels for the category division.

Table 1. CTCPEC Profile Equivalent to TCSEC Class C2

Functionality	Division/Mechanism	Level
Confidentiality	Discretionary	2
	Object Reuse	1
Integrity	Discretionary	1
	Separation of Duties	1
	Self Testing	1
Accountability	I & A	1
	Audit Level	1

Table 2. CTCPEC Profile Equivalent to TCSEC Class B1

Functionality	Division/Mechanism	Level
Confidentiality	Discretionary	2
	Mandatory	2
	Object Reuse	1
Integrity	Discretionary or Mandatory	1
	Separation of Duties	1
	Self Testing	1
Accountability	I & A	1
	Audit Level	1

The European ITSEC Approach

The ITSEC also has separated the functionality into a separate rating from the assurances or, as stated in the ITSEC, the effectiveness and correctness aspects of assurance. There are ten example functionality classes. The first five are closely tied to the TCSEC classes (F-C1, F-C2, F-B1, F-B2, and F-B3). Table 5 maps the ITSEC classes to the TCSEC classes. This mapping is a general guide, the two criteria schemes do not directly correspond to each other.

The other five classes are new in the ITSEC: high integrity requirements (F-IN); high requirements for availability of complete or special functions of the target (F-AV); high requirements for data communication integrity (F-DI); high demands for data communication confidentiality (F-DC); and networks with high demands on confidentiality and integrity of information (F-DX). These classes are examples and not obligatory. They can only be used if the target (product or system) contains all aspects of the class. A target may reference one or more of these example functionality classes to define part or all of its functions. As an alternative to the use of the example pre-defined functionality classes, the sponsor of evaluation can specify the security enforcing functions of the target.

There are seven possible correctness levels (E0, E1, E2, E3, E4, E5, and E6) described in the ITSEC. In addition, following the evaluation of the correctness, an assessment of effectiveness based on a vulnerability analysis of the target is performed. There is a pass/fail designation of the evaluation on effectiveness grounds.

Table 3. CTCPEC Profile Equivalent to TCSEC Class B2

Functionality	Division/Mechanism	Level
Confidentiality	Covert Channels	1
	Discretionary	2
	Mandatory	3
	Object Reuse	1
Integrity	Discretionary or Mandatory	1
	Separation of Duties	2
	Self Testing	1
Accountability	I & A	1
	Audit Level	1
	Trusted Path	1

Table 4. CTCPEC Profile Equivalent to TCSEC Class B3

Functionality	Division/Mechanism	Level
Confidentiality	Covert Channels	1
	Discretionary	3
	Mandatory	3
	Object Reuse	1
Integrity	Discretionary or Mandatory	1
	Separation of Duties	2
	Self Testing	1
Availability	Recovery	1
Accountability	I & A	1
	Audit Level	2
	Trusted Path	2

The ITSEC approach is more flexible, and more open to interpretation by all of the national certification bodies which will perform the evaluations. This flexibility may limit the ability for any future reciprocal recognition of certifications. The actual practice in the use of the criteria in the future will determine the feasibility of this approach. For the systems integrator, this approach has the potential to evolve into four different practical usages, one for each of the involved countries: United Kingdom, The Netherlands, France and Germany.

Use of the Three Criteria

For an example of the rating of a product under each of the schemes, we selected a fictional product that is an M-Component (Mandatory Access Control) under the TNI with a rating of TCSEC Class B1 M-Component. The TNI "allows for the evaluation of components which in and of themselves do not support all the policies required by the TCSEC" but which can be reused "in different networks without the need for a re-evaluation of the component." [7]

This same product when rated under the CTCPEC would have a rating of CM-1, CR-1, WI-3, and T-3. This designation is a clear correspondence between the two criteria, TCSEC (TNI) and the CTCPEC. The correspondence is not as clear to the ITSEC scheme. The closest ITSEC example rating is F-B1 and E3. However, a F-B1 has requirements which do not correlate to the M-Component designation of the TNI (e.g., Identification and Authentication, "A.20 The TOE shall uniquely identify and authenticate users" [5]). Further, there are requirements for F-B1 which are not designated in the U.S. scheme for a B1 M-Component, reference [1] page 48.

Approach Conclusion

This discussion of the differing terminologies, requirements, and approaches of the three criteria must lead to the conclusion that there is no consistency between them. This inconsistency leads to confusion in the systems integration community among others. The potential effects that this confusion will have on this community are discussed below.

Table 5. ITSEC to TCSEC Mappings

TCSEC Class	ITSEC Class
D	E0
C1	F-C1, E1
C2	F-C2, E2
B1	F-B1, E3
B2	F-B2, E4
B3	F-B3, E5
A1	F-B3, E6

Systems Integrator Perspective

Systems vendors and integrators, who expect to survive through the decade of the 90s, will have to contend with the trusted systems criteria discussed above. Their differing requirements and approaches, and the implications of their use will determine international competitiveness.

What is a Systems Integrator?

In this paper, the term System Integrator is defined as follows: A systems integrator provides the expertise to cost effectively bring together divergent products from multiple product lines to solve a specific operational problem in a specific installation. In the case where the problem includes protection of information, some of the products will have security functionality, and will likely have been evaluated by one of these international schemes.

Systems integrators, as defined for this paper, typically respond to Requests for Proposals (RFPs) and Invitation for Bids (IFBs) from Governments and related Organizations, such as the North Atlantic Treaty Organization (NATO), solving a specific problem (part of which is assumed to include security) in a given environment. Procurement documents must be developed such that vendors with solutions based on approved products from any evaluation scheme could compete. Such procurement documents would contain phrases such as: the proposed solution shall comply with all requirements for ITSEC F-B1, E3. Systems integrator teams would then design a solution which was composed of subsystems and products which met the requirement in the most cost effective combination.

Of course, the solution to any large requirement usually requires combining (evaluated) security products into more complex systems. The analysis of the total problem, with security considerations, requires that the security team be conversant with the entire architecture, each of the evaluation schemes, and the products/technology evaluated under each scheme.

When the requirement is stated in terms like: the offerors' solution must be capable of evaluation at the TCSEC C2 level, the integrator's problem is compounded. Products which have been evaluated according to one scheme may not be acceptable, or meet the analogous level in the others. The team must consider the most cost-effective path to satisfying the requirement and that path may require including an evaluation (or re-evaluation) of a product or assurance documents in the overall cost.

What Do Multiple Evaluations Mean to Systems Integrators?

Vendors having products which have been evaluated on more than one scheme will, of course, be reluctant to draw distinctions among criteria. They are in business to sell products, not necessarily to solve a given specific operational problem.

Micronyx, an international vendor of a product, TriSpan, have listings in the UK Certified Security Products List (UKSP), and the U.S. Evaluated Products List (EPL). The product was advertised in Infomatics [4] as UK Government Certified and U.S. NCSC Certified. Indeed, the 1 October 1991 UKSP lists TriSpan version 1.2130 as meeting UKL2 (Independently Tested). The U.S. NCSC EPL-SUM-89/007, however, gave the product an overall rating of TCSEC Class D, for Identification and Authentication (I&A), Discretionary Access Control (DAC), and Audit, stating that it does not meet the assurance and documentation requirements for a higher rating.

A trusted systems integrator contemplating using such a product to meet an overall requirement of any of the equivalent evaluation ratings, as described earlier, must be able to accurately estimate the costs to develop assurance and documentation which may be required by the accrediting or approving official.

Causes for Ambiguity

An international systems integrator is faced with ambiguity caused by several factors. Each of the principals involved with these criteria has autonomy to construct evaluation schemes, and maintain separate lists of evaluated products. Currently Canada, the UK and the U.S. have such schemes in place and soon there likely will be six lists.

Technology Export Restrictions

Six lists, mostly kept by the Intelligence community, implies loads of red tape to export technology, even if the techniques are already in documented use in the intended market. A striking example of this now is the Data Encryption Standard (DES) controversy. All the major U.S. vendors of systems like International Business Machine Corporation (IBM), Digital Equipment Corporation (DEC), Hewlett Packard (HP), etc, incorporate DES

in the security functions of their offerings. The DES modules must be removed, or very costly negotiations must be engaged to allow selling their products outside the U.S., even though DES is well documented, and other sources for it exist outside the U.S. Similar restrictions are being applied to any products rated B3 or higher under the TCSEC.

Language Translation

Additionally, the six lists are, of course, maintained in the native language of the keepers. The nuances described earlier in this paper are exacerbated with translation. Each scheme is likely to have an array of "interpretations and guidelines" such as now exist in the U.S. scheme. Both the CTCPEC and ITSEC contain requirements which are not found in the TCSEC, and will therefore, require additional explanation of how these requirements could be met by U.S. EPL products.

Standards and Security Requirements

The inherent ambiguity which must be resolved by system integrators is aggravated by divergent standards. Security products are built to comply with criteria, not International Standards Organization (ISO) standards. When both standards and evaluation ratings are stated as requirements in procurements, the system integrator must usually make a compromise. A detailed technical knowledge of both will be required to develop a cost effective solution which complies with the intent of standards and security requirements.

Generational Problems

The multiple evaluation syndrome is compounded by what may be termed the "generational" problem. As criteria and schemes evolve, and products are evaluated, systems integrators must know when the evaluation was completed in order to assess its usefulness. The UK evaluation scheme predates the ITSEC. The CTCPEC states that revisions may be annual. (In fact, a major revision to the CTCPEC was released between the time that this paper was conceptualized and written, requiring major changes to this paper which superficially describes the approach. A wonderful example of the pitfalls and frustrations caused by generations of criteria.) Additionally, the U.S. has come out with the review draft of a new federated criteria that replaces the TCSEC. [12, 13]

It is clear that procurement professionals won't stay abreast of these changes. Several recent U.S. procurements required solutions to comply with the 1983 version of TCSEC, and it is very difficult to ascertain which products were evaluated using that criteria. Product vendors will naturally strive to get commitments from evaluators to freeze requirements before evaluations are begun, to avoid moving targets. Subsequent users of those products will necessarily need to know this information when developing specifications for systems.

Suggestions for Community

This paper has surfaced a number of issues which result in the following suggestions for the community. The community includes product vendors, evaluators, national certification bodies, procurement professionals, accreditation officials and systems integrators -- to name a few.

"Keeper" of Evaluated Products Lists

Find a "keeper" for the lists of nationally evaluated products. Everyone can profit from others' work if some registry existed which points to evaluations completed internationally. Some international organization, such as the United Nations, could be approached to maintain this registry. (It appears that in the new world order, NATO may be looking for some jobs to do!)

Reciprocal Evaluations

Develop reciprocal evaluations using the three criteria. If a registrar could be found, this may open the way for the negotiation of international mutual recognition of evaluations. There is some work going on now in this regard between the TCSEC and the CTCPEC, or U.S. and Canada. In the near term, a single list of evaluated products is beyond our reach. But imagine the benefits to be gained by having a coordinated worldwide list of evaluated security products!

International Standards for Trusted Systems Criteria

Develop an international standard for trusted systems criteria. Even better than a single list of products evaluated against several criteria would be a single international trusted systems criteria standard. Is anybody trying to coordinate the various trusted systems criteria and the ISO? Clearly the

community will profit if eventual ISO standards in security services can be provided by evaluated products. This work seems to be beginning and is applauded.

Universally accepted standards are vendor driven. Vendors naturally push the standards which they do offer or can offer in their own products. But, having several international security criteria, the vendors are not going to be economically able to support all of the criteria. It is therefore important to have this criteria coordinated closely with the international standards committees.

Evolution of Technology

Perform more analysis, such as the paper in 14th National Computer Security Conference [1]. This paper compares the requirements of TCSEC Class B3 and ITSEC example class F-B3, E5. The comparison of specific products to potential evaluations (Targets of Evaluation) sheds a much needed light on differences and similarities in these criteria. The real burden is on trusted systems professionals to stay abreast of this evolution in technology, and attempt to inform the rest of the community. Such participation in the process results in more consistent practices internationally and diminished ambiguity in reporting results.

Bibliography

[1] Branstad, Dr. Martha, et al, "Apparent Differences between the U.S. TCSEC and the European ITSEC", Proceedings: 14th National Computer Security Conference, Vol 1, page 45-58, October 1991.

[2] Canadian System Security Centre, Communications Security Establishment, Government of Canada, The Canadian Trusted Computer Product Evaluation Criteria (CTCPEC), Version 3.0., April 1992.

[3] Department of Defense, Trusted Computer System Evaluation Criteria (TCSEC), DoD 5200.28-STD, December 1985.

[4] Infomatics, "Security Survey", VNU Business Publications, Vol. II, No. 7, page 74, July 1990.

[5] Information Technology Security Evaluation Criteria (ITSEC), Provisional Harmonized Criteria, Version 1.2. 28 June 1991.

[6] Information Technology Security Evaluation Manual (ITSEM), Commission of the European Communities, Draft V0.2, 1992.

[7] National Computer Security Center, Trusted Network Interpretation of Trusted Computer System Evaluation Criteria, NCSC-TG-005, 31 July 1987.

[8] National Computer Security Center, Trusted Database Management System Interpretation of the Trusted Computer System Evaluation Criteria, NCSC-TG-021, Version 1, April 1991.

[9] National Computer Security Center, Computer Security Subsystem Interpretation of Trusted Computer System Evaluation Criteria, NCSC-TG-009, Version 1, 16 September 1988.

[10] National Computer Security Center, Trusted Product Evaluations, A Guide for Vendors, NCSC-TG-002, Version 1, 22 June 1990.

[11] National Computer Security Center, Rating Maintenance Phase, Program Document, NCSC-TG-013, Version 1, 23 June 1989.

[12] National Institute of Standards and Technology & National Security Agency, Federal Criteria for Information Technology Security, Volume I, Protection Profile Development, Version 1.0, December 1992

[13] National Institute of Standards and Technology & National Security Agency, Federal Criteria for Information Technology Security, Volume II, Registry of Protection Profiles, Version 1.0, December 1992

DEVELOPING FUTURE ACQUISITION MANAGERS WITH BEHAVIORAL SIMULATIONS

Dr. Owen C. Gadeken, Defense Systems Management College
Dr. Lawrence Lerer, Defense Systems Management College

ABSTRACT

The Defense Systems Management College (DSMC) is continually searching for innovative training approaches and methods to prepare the acquisition workforce for the management and leadership challenges of the future. The traditional classroom lecture has gradually given way to the seminar, case study and now the simulation. This paper will highlight a new simulation methodology: behavioral, in-basket, organizational simulations. A variety of these simulations are now being developed and used in all aspects of the DSMC curriculum. The paper will lay out the general characteristics of simulation training as well as the unique aspects of behavioral simulations as they are employed at DSMC. The variety of DSMC simulation applications will be explored along with the contribution these simulations are making in addressing acquisition management issues and challenges of the future.

BACKGROUND

For many years, cold war politics, the superpower arms race and resulting big defense budgets fueled a massive U.S. Defense acquisition program. However, with the dissolution of the communist block, heightened international economic competition and the advent of a new Democratic administration, U.S. Defense acquisition programs and personnel will likely be trimmed to their lowest levels in recent history. In this smaller acquisition workforce of the future, an even greater premium will be paid for developing top flight acquisition managers who can operate effectively in a highly constrained resource environment. Just as the new acquisition environment calls for acquisition managers to develop new and more effective management approaches, so too will the organizations which train these future managers need to develop new and more effective training methods.

Recent research has confirmed what managers and many educators have believed for years; adults learn best when they perceive that the leaning is of value to their life and their work environments. The work of Malcolm Knowles indicates that adult learning primarily is self-motivated; adults learn what they need to know when they understand it to be important, with a strong emphasis on application. Instructors/facilitators working with adults cannot directly transfer knowledge or skills to the adult learner; at best those charged with the mission of educating adults can serve as guides, as managers of the learning process, in creating the environment so that adults can engage in self-directed learning.

This suggests that for such an environment to be optimal, it should involve some elements that simulate

real-life experiences as closely as possible, and integrate this "learning by doing" with theoretical hypotheses.

It is within this context that the Education Department at the Defense Systems Management College (DSMC), Fort Belvoir, Virginia has been involved over the past seven years in using behavioral simulations in teaching and research activities focusing on developing managerial and executive skills. Student feedback has supported our premise that such simulations are powerful learning tools that can concentrate over a short period of time what can take much longer to learn whether on the job or in a more "traditional" classroom environment. Benefits of using behavioral simulation training are summarized in Figure 1.

The first simulation used by DSMC is the Looking Glass management simulation which was developed by the Center for Creative Leadership. Looking Glass is used as an elective in the 20-week Program Management Course (PMC) and as a featured part of the 3-week Executive Management Course (EMC). The commercial manufacturing scenario is not closely related to that found in a Defense acquisition organization. However, the simulation's managerial issues have considerable parallel to those faced by Defense acquisition managers. The commercial scenario also provides a "neutral playing field" for Defense managers to focus on developing their personal skills (instead of concentrating on content issues in the simulation).

Based on the positive response of both faculty and students to the Looking Glass simulation, two behavioral simulations were developed in conjunction with the Management Simulation Projects (MSP) Group at New York University. The first simulation focuses on key content issues involved in contract management, and is set in a government contracting office. This simulation is used as an instructional tool in a mandated two-week course on systems acquisition for contracting personnel assigned to a major weapon system program office or who spend at lead half of their time supporting a major weapon system program. It is also available as an elective to students taking the PMC and EMC classes.

The second simulation is designed to deal with management behaviors in the context of a food company (Foodcorp II). This simulation focuses primarily on observing management behaviors using Baldridge and Excelsior Quality Management Award Criteria as a baseline. At present, plans call for offering this simulation as an elective in the PMC, and incorporating it into an executive development program for acquisition managers being designed by DSMC's Education Department.

The Education Department is also developing a new project management simulation consisting of a series of integrated vignettes which will require participants to demonstrate key program management competencies. A NASA lunar mining base was chosen as the scenario to establish an acquisition related situation but a content neutral (non-DoD) backdrop to focus on assessing and developing participants' managerial and executive skills.

Figure 1. Benefits of Behavioral Simulations

- o Are inherently interesting and motivating
- o Allow tailored assignments to fit student needs
- o Allow students to experience the different stakeholder perspectives that affect the outcome of major organizational decisions and actions
- o Give the students a feeling (or gestalt) of what it is like to manage in a complex, realistic management environment.
- o Put the focus squarely on the leadership and management skills found to be most critical to organization and program success
- o Provide real-time feedback from multiple sources (self, peers and facilitators as well as comparison with prior simulation experiences)
- o Encourage transition from classroom learning to job application

BEHAVIORAL SIMULATIONS

A behavioral simulation is an intensive experience emphasing learning by doing, and providing time for personal reflection and feedback from both the simulation facilitator and other participants. Frequently, behavioral simulations involve a variety of roles, each related to the key issues undergirding the simulation. Each role contains extensive information on past activities, correspondence on current practices, decision situations, and critical issues faced by the organization. Through observing such behaviors as problem solving, decision making, and priority setting, simulation participants are provided feedback on their behaviors, and are then able to make self-assessments as to the efficacy of such behaviors.

Behavioral simulations are vehicles or technologies that will allow us to hone in on the interpersonal behaviors and dynamics among people as strategic and tactical objectives emerge--issues which involve coordination, articulation, and integration among individuals, work teams and outside stakeholders. As DoD continues to deal with the realities of shrinking resources, revised objectives and new missions, acquisition managers are forced to face the paradox of balancing daily short term demands with long term strategic issues and an ever changing climate.

Behavioral simulations provide realistic and focused but neutral environments which allow participants to develop plans to meet the organizational challenges, and then reflect on these behaviors as they received peer and facilitator feedback. The need to receive and provide data; to apply written and oral communication skills; to set priorities; allocate resources and specify goals; and manage and negotiate often conflicting goals and objectives are all inherent to a well designed behavioral simulation.

PROGRAM DESIGN

The design of the behavioral simulation, to be effective, must emerge from the goals and objectives of the experiential learning method, and be compatible with the goals and objectives of the educational program within which the simulation is nested. At best, simulations are tools, perhaps even enabling technologies. Their value is optimized when well integrated into the goals, objectives and conceptual underpinnings of the educational programs they support.

The following are some questions, the answers to which inform and stimulate design considerations:

- o What are the desired educational (behavioral) outcomes?
- o How much time is to be allocated to the simulation?
- o What pre-reading or other preparation is required?
- o What special logistical requirements must be considered?
- o What are they key follow-up and assessment activities?

- o How many participants can be accommodated?

- o What special facilitating skills are needed?

As an example, DSMC's current Looking Glass Design is illustrate in Figure 2.

COMPARISONS

Behavioral simulations emphasize learning through doing, as compared with case studies which focus on the application of cognitive learning or computer-based simulations which focus on analysis-based learning. Case studies with their emphasis on application and synthesis in the cognitive domain require participants to function in an almost consultant like role. Computer-based simulations cause participants to compete within the constraints of a programmed model; effectiveness is measured against the model's design rather than through the interactions and behaviors of participants. The similarities and differences between these learning vehicles are summarized in Figure 3.

SUMMARY

Currently, Defense acquisition organizations are competing in uncertain, challenging, risk-filled environments. Therefore, there is the ever constant need to balance short term tactical objectives against longer-term strategic issues and a multitude of constraints. Behavioral simulations allow future acquisition managers to experience and receive feedback on how these challenges can best be addressed.

BIBLIOGRAPHY

1. Gadeken, O.C. "DSMC Simulations: Games That Teach Engineers and Scientists How to Manage." *Program Manager*, May-June 1989.

2. Knowles, M.S. *The Modern Practice of Adult Education: From Pedagogy to Andragogy*. Chicago: Association Press/Follett, 1980.

3. Krause, M.G. "Running a Glass Company Can Make You a Better Manager: The Looking Glass Experience." *Program Manager*, May-June 1988.

4. Lerer, L. and Summers, W. "The Contract Management Simulation: A Tool for Learning." Proceedings of the 1991 Acquisition Research Symposium (Volume Two).

5. Stumpf, S. and Arnone, M. *Foodcorp II Trainer Guide*. New York: MSP Institute, 1992.

Figure 2.

LOOKING CLASS SIMULATION SCHEDULE

DAY	1	2	3
MORNING		SIMULATION	TEAM EVALUATION AND FEEDBACK
AFTERNOON	INTRODUCTION	SIMULATION QUESTIONNAIRES	INDIVIDUAL EVALUATION AND FEEDBACK
EVENING	HOMEWORK: READ TAILORED CASES	DEBRIEFING	

Figure 3. Comparison of Case Studies, Computer and Behavioral Simulations

	Case Studies	Computer Simulations	Behavioral Simulations
Materials	One case	One case with computer instructions	Individually tailored cases
Viewpoint	Students view case from same perspective (as external consultants)	Students view case from same perspective (as competitors)	Each student has a different role, information and perspective
Approach	Analyze problems and propose solutions	Students compete with each other and against computer model	Students assume roles with instructors as observers/role-players
Class Session	Instructor-led seminar	Interaction with computer	Interactive experience
Results/Product	Logical analysis and acceptable solutions	Computer analysis and comparison with other participants	Personal feedback on both content (what was done) and process (how it was done)
Evaluation	External assessment	External assessment	Self assessment

CUSTOMER SATISFACTION IN DEFENSE ACQUISITION

Forrest C. Gale

Defense Systems Management College

ABSTRACT

This paper reports interim results of ongoing action research on customer satisfaction. The research is designed to assess the results of the application of behavioral change technology which addresses the following questions: (1) What are the components of customer-supplier interaction? (2) What are the mechanisms whereby the negotiation and interaction between customer and supplier result in the customer-supplier agreement complex? (3) What are the generic structural, environmental, experience-based, and species-specific precursors to customer-supplier agreement? (4) What is the nature of the behavioral phenomena we call "satisfaction"? And (5) what motivates a customer (and--reciprocally--a supplier) to be "satisfied"? this paper reports data and information obtained from a random number-selected sample of 494 leaders, managers, and professionals in military service organizations, civilian government agencies, and in private sector business organizations. This sample was selected out of a base population of 3872 individuals encountered in the conduct of custom educational experiences and consulting assignments during the 1987-1993 time interval. The reported interim results provide a developing framework within which one can begin to perceive the outline of a practical customer satisfaction strategy which is based on the formal application of behavioral change theory. This is seen by the author as an integrating contribution to the leadership activity of strategic thinking and planning, wherein a major component and focus of that activity becomes the formalized strategizing of behavioral change.

INTRODUCTION

The fundamental goal of all quality-related activity in organizations is customer satisfaction. This basic purposing premise underlies the quality theories of W. Edwards Deming, Joseph Juran, Kaoru Ishikawa, and many others cited referentially in the literature of Quality. This single purposing objective, achieved via the transformation (by human and human-machine enactment of processes) of resources into products and services, differentiates the managerial and leadership focus afforded by the Quality paradigm from that of all the other traditional enacting frameworks of leadership and management. As an example of the traditional framing of management and leadership objective, consider that in many organizations the objectives of cost, schedule, technical product performance, and efficiency are the overriding focus of management attention, leadership vision,

and the supporting culture. In many such organizations, these outcomes are seen as ends in and of themselves, rather than as by-products of organizational (process enactment) activity focused on customer satisfaction via the delivery of product and service quality.

Systems theory tells us that one must understand the goals and objectives of a system to understand the system. If the system is Quality, can it be anything less than critically important to understand the consummate goal of quality effort, which is customer satisfaction? To date, the literature of quality has focused on the tools, techniques, theories and philosophies, and to a lesser extent on the systems of quality enactment and the sustaining environment. Little of substance has been written on the enacting mechanisms of a quality system's most singular purpose.

Without an understanding of satisfaction and its attendant dynamics, the quality practitioner is in the position of applying quality theory, tools, techniques, and systems in an environment characterized by a critically flawed premise: that one must only satisfy customer "needs" in order to attain the super-ordinate system goal. The results of the research reported in this paper provide a much more powerful and empowering set of insights--grounded in a theoretical framework--upon which to base behavioral change strategy centered on customer satisfaction.

The Customer-Supplier Agreement

The research undertaken in this project involved interviewing and interacting with defense acquisition professionals and a variety of support staff. Through the hybrid medium of the structured interview process and a series of small team process interventions utilizing a focus question protocol and image-based communication tools, data was collected that represents the actual practice of conceiving, planning, negotiating and enacting a formal customer-supplier agreement. The content of these agreements varied widely, but the process elements invariably cited by respondents as providing a framework for successful enactment of the agreement became obvious as we statistically combed the data base citations. As a set of attributes of agreement, these elements clearly delineate what is required to make a successful quality agreement and then create customer satisfaction (and supplier satisfaction) in the enactment of the subject agreement.

There follows (Figure 1) a listing of these attributes of agreement. The attribute citations were accepted only from those respondents who indicated successful enactment of the subsequent agreement, and who also indicated that their reciprocal partner (customer or supplier) specifically stated "satisfaction" with the enactment. Further, only those respondents who indicated their own "satisfaction" with the outcome of the enactment were included in results of figure 1

and in the citation acceptance process. This dual satisfaction population numbered 3872 individuals. A random sample of 494 of these individuals who then selected for more extensive analysis, the results of which are cited throughout this paper.

CUSTOMER-SUPPLIER AGREEMENTS

Process Element	Respondent Citations (%) Supplier (%)	Customer (%)
Specific ID of Product/Service	98	91
Specific ID of Customer as "Customer"	74	--
Customer Classification (Internal/External)	67	--
Customer Attributes Model Construction	56	--
Customer Quality Model Construction	61	--
Specifically Seek/Determine Reciprocal Wants (Requirements)	85	60
Specifically Seek Reciprocal Needs (Desires)	77	55
Determine in Totality What Will Satisfy	64	39
Determine Current Process Capabilities	51	27
Determine Potential Process Capabilities	19	4
Determine Available Resources (To Process)	82	--
Inform on Available Resources (To Process)	46	--
Inform on Current Process Capabilities	36	--
Assessment of Internal Environmental Factors	77	33
Assessment of External Environmental Factors	80	73
Jointly Determine Quality Factors	44	34
Negotiated Quality Agreement	82	85
Formalized (Explicit) Quality Agreement	91	88
Renegotiation Required During Enactment	64	73
Agreed to Concurrent Process and Product Design	70	53
Informed Customer of Process During PDCA Cycle	51	--
Continually Sought Feedback on Environmentally Induced Quality Factor Changes During PDCA Cycle	38	4
Delivered Product/Service With Agreed-Upon Quality Factors	90	81
Sought Continuous Feedback on Satisfaction	85	44
Continuous Customer Education on Product Capabilities/Improvements/Opportunities	79	--
Continuous Customer Education on Process Capabilities/Improvements/Opportunities	46	--
Continuous Customer Education on Resource Availabilities, Adequacy, Quality Impacts	86	--

Process Element	Respondent Citations (%) Supplier (%)	Customer (%)
Continuously Sought Product Improvement Through:		
- Internal Environmental Search	95	5
- External Environmental Search	25	82
- Ongoing Customer Feedback	66	78
- Opportunistic Technology Search	95	40
- Teaming With Customer	47	--
Continuously Sought Process Improvement Through:		
- Internal Environmental Search	59	4
- External Environmental Search	43	26
- Ongoing Customer Feedback	68	75
- Opportunistic Technology Search	95	41
- Stakeholder Teaming With Customer	26	--
Specific ID of Supplier as "Supplier"	--	95
Supplier Classification (Internal/External)	4	63
Supplier Attributes Model Construction	--	13
Supplier Quality Model Construction	--	11
Articulate, Quantify, Record Needs	82	88
Articulate, Quantify, Record Wants	64	79
Inform Supplier of Needs	--	98
Inform Supplier of Wants	--	92
Identify/Articulate NON Product/Service "Satisfaction" Attributes	22	67
Inform Supplier of NON Product/Service "Satisfaction" Attributes	--	43
Inform Supplier of Current Product/ Service Use Environment:		
- Influences	--	44
- Change Rates		4
- Future/Forecasts		12
Seek/Internalize Information on Supplier Process Capabilities	--	49
Seek/Internalize Information on Supplier Resource Availabilities	--	29
Inform Supplier of Product/Service Boundaries and Constraints:		
- Economic	--	81
- System-Derived	--	66
- Political/Social	--	51
Continuous Monitor Supplier Progress (PDCA)	--	78
Continuous Feedback to Supplier on:		
- Environmentally Induced Quality Factor Changes	--	53
- Needs/Wants-Induced Quality Factor Changes	--	62

Process Element	Respondent Citations (%) Supplier (%)	Customer (%)
Provided Continuous Feedback to Supplier on:		
- Quality Performance Data	--	64
- Introduction/Installation	--	82
- Test (Initial)	--	61
- Volume Usage	--	43
- User Experience	--	79
- Customer Satisfaction	--	77
- Process Improvement Opportunities	--	7
Seek/Internalize Education on:		
- Supplier Product/Service Capabilities	--	24
- Improvement Opportunities	--	11
- Supplier Process Functioning	--	60
- Supplier Process Capabilities	--	39
- Supplier Process Improvement Opportunities	--	5
- Supplier Resource Availabilities, Adequacy, Quality Impacts	--	11

FIGURE 1 - ELEMENTS OF SUCCESSFUL CUSTOMER-SUPPLIER AGREEMENTS

Though the data is preliminary and the research is ongoing, the elements for successful customer-supplier agreement are manifest in the results evident to date. Specific identification of the transacted product or service is requisite. Customer and supplier roles in each portion of the agreement must be clearly and specifically outlined. Customer classification (internal/ external) must be explicated. Suppliers must seek out and exactly determine customers' needs and wants; it appears to be slightly less important for customers to seek out suppliers needs and wants though--as we shall see as we later examine the psychology of quality agreements--both are critically important in achieving "satisfaction", as the customer-supplier agreement is a boat in which both customer and supplier ride the tide of mutual satisfaction to a successful conclusion. There is a saying in quality that the data appears to validate: "It takes a world class customer to make a world class supplier."

Both customer and supplier in successful quality agreements appear to articulate, quantify, and record needs and wants. Suppliers appear to be much more involved in determining the totality of satisfaction (outside the realm of direct product or service), and are somewhat more active in investigating the reciprocal needs and wants of the opposite constituencies. Customers are uniformly more vigorous in informing suppliers of their needs and wants than are suppliers similarly informing customers. The latter inclination did not seem to harm performance and--ultimately--satisfaction on the agreements cited.

Suppliers cited the determination of process resources as a dominant success factor, while successful customers seem not to seek out such information. Assessment of external environmental factors was a success element of both suppliers and customers, but internal environmental assessment was frequent only in successful supplier constituencies. Nevertheless, successful customers frequently cited providing continuous feedback to suppliers on: (1) product/process introduction, installation; (2) user experience with the subject product/process; and (3) on satisfaction with performance on the agreement.

The negotiation of a quality agreement rather than dictation of the quality factors by edict or fiat was frequently cited by both successful customers and suppliers. Moreover, an even higher percentage of respondents cited the practice of formally and explicitly recording the agreed-upon quality factors, no matter how seemingly trivial the agreement. Nearly three-quarters of all respondents also cited the requirement to renegotiate these factors during the course of enactment of the agreement. This was apparently facilitated by an agreement by more than two-thirds of the responding suppliers to design processes and products/services concurrently whenever new products or services were involved. The latter practice would appear to be a result of heightened customer awareness of the concurrent engineering process and its applicability to a wide variety of both product and service developments.

The communication interface between customer and supplier and the dynamics of that interface received considerable emphasis in the respondent's citations. Successful suppliers overwhelmingly sought continuous feedback on satisfaction from customers, while the reverse was true in less than 50% of the instances cited by customer respondents. In the realm of product improvement, successful suppliers continuously sought out opportunities via organization-internal environmental search, opportunistic technology search, and--to a lesser extent--through ongoing customer feedback. Customers sought product improvement through external environmental search (what is out there? Who else is doing something better?), and through the mechanism of feeding this information back to responsive suppliers. Successful respondent customers most frequently cited information flow to suppliers in product/service boundaries and constraints in economic, and--to a lesser extent--system-derived areas of concern. Finally, successful customers provided continuous feedback to suppliers on need and want-induced quality factor changes. Coupled with the better communication, these self same successful customers frequently identified and articulated <u>non</u>-product/service "satisfaction" attributes to suppliers, and included these factors in the

negotiated quality agreement.

Successful suppliers overwhelmingly sought continuous process improvement through opportunistic technology search and--to a lesser extent--through ongoing customer feedback. Respondent customers, however, cited ongoing feedback to suppliers as their primary process improvement mechanism. To improve customer knowledge and investment in their products and processes, successful suppliers pursued continuous customer education on product capabilities, improvements, and opportunities; and on resource availabilities, adequacy, and quality impacts. Successful respondent suppliers did not seek to educate customers on their processes in spite of what appears to be a rather substantial opportunity to do so. Alternatively, less than half of successful respondent customers continuously sought to obtain, internalize and act upon supplier process information. Nevertheless, nearly four out of five respondent customers reported monitoring supplier progress during the enactment of the quality agreement.

An interesting anomaly appeared in the respondent customer-supplier data with respect to the perception of satisfaction resulting from the enactment of the subject quality agreement, and with respect to the fidelity of that enactment. Though all customer-supplier respondents cited "satisfaction" as the outcome of the agreement enactment, only 90% of the respondent suppliers and 81% of the respondent customers reported delivering product or service with the agreed-upon quality factors. This anomaly induced the researchers to probe the issue of satisfaction itself, using the structured interview and small group intervention format previously described, together with the application of theories of motivation to test the hypothesis, "The motivation to be satisfied can be explained by Deming's hypothesis on quality delights and by Vrooms theory."

<u>Components of Customer Satisfaction</u>

Slightly more than 80% of the customer-supplier respondents in our sample reported experiencing more than two levels of satisfaction from successful enactment of their subject quality agreement. In order to explore this finding, we attempted to obtain a generic understanding of these levels by requesting an experience-based definition from respondents. The following set of definitions (Figure 2) describes the composite response:

<u>Needs</u>: Elements of product or service satisfaction below which basic ability (usefulness) is compromised (i.e., not useful). For our suppliers, being able to meet needs constituted, by their own description, the entree (poker chip; the necessary ante) into the competitive market place.

<u>Wants</u>: Elements of product or service satisfaction that constitute the majority of the grist of the competitive market place. These were described by our respondents as "nice to haves; features; more for the same/less compensation (both physical/economic and psychological); but always above the level of basic utility."

<u>Delights (after Deming)</u>: Elements of product or service satisfaction offered by an "inside-the-customer-mind-and-heart" supplier; creatively/innovatively generated by a leading-edge supplier from superior knowledge of <u>both</u> self-generated product or service (and process) <u>and</u> implied/inferred/sensed higher order desires <u>not even/yet expressed by the customer</u>. This was further described by respondents as: "I know they (customer) would love this if they had it; create/make the market; lead direction, pace, substance, texture of market through the ability to opportunistically capitalize on superior customer <u>and</u> product/service knowledge".

<u>FIGURE 2 - LEVELS OF SATISFACTION DEFINITIONS</u>

Thus, it can be said that customer satisfaction equals needs (market entree), plus wants (market competition), plus delights (lead or create the market). It was no surprise to our competition-weary suppliers nor our vaguely dissatisfied customer respondents to realize that supplying needs alone rarely provides complete or long term customer satisfaction. In this vein, some respondents noted that customers ceaselessly search for a higher level of satisfaction, and will leave in droves when a better mousetrap for equivalent compensation appears on the horizon. Sic transit loyalty. Such discussions have led us to propose a model for the three apparent levels which we have come to call "The Golden Staircase."

THE CUSTOMER SATISFACTION STAIRCASE

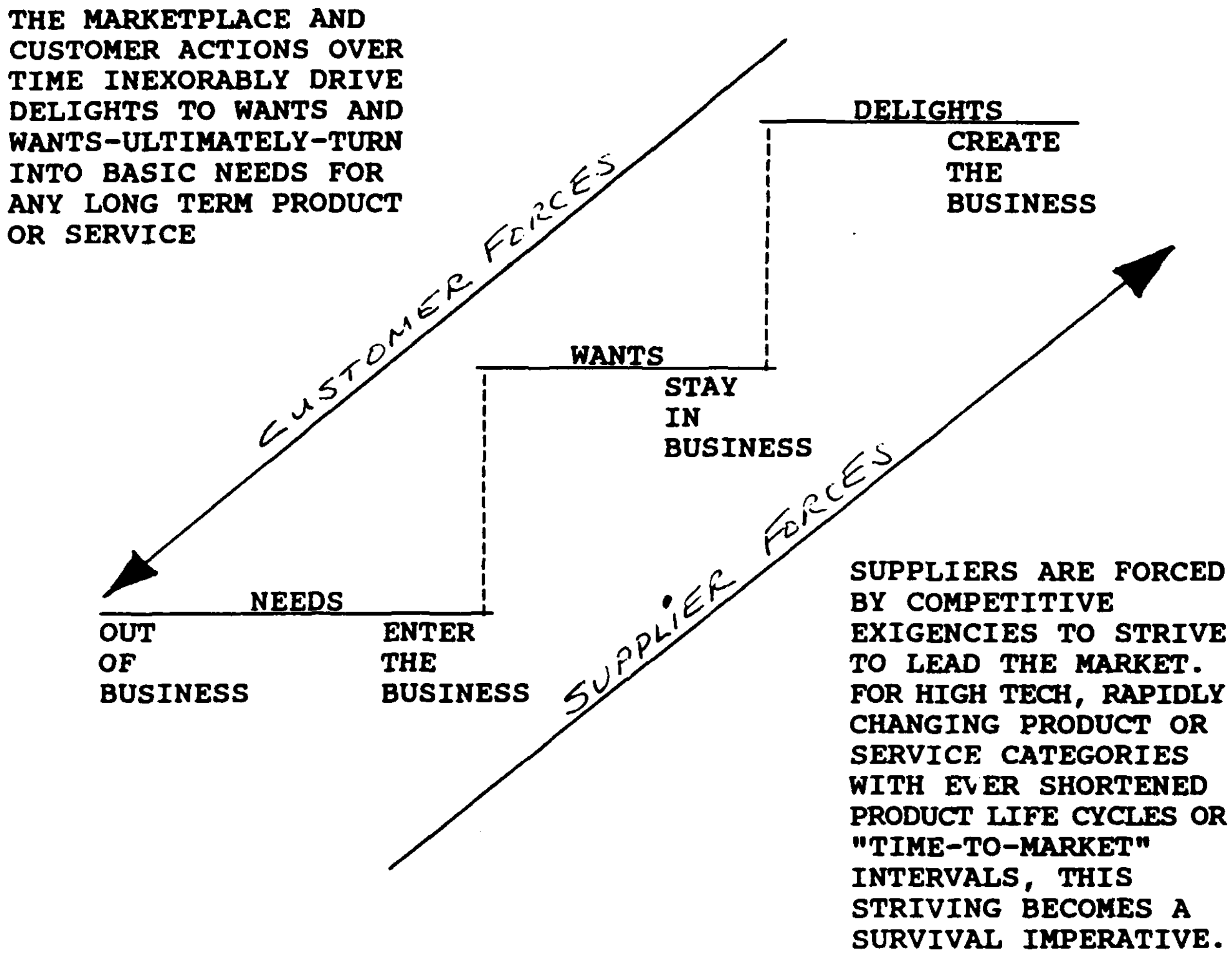


FIGURE 3 - THE GOLDEN STAIRCASE

Examination of the Golden Staircase concept reveals that environmental forces in the market are in opposition for customers and suppliers. Suppliers continuously seek to drive up the staircase to lead the market, and thus dominate it. This position of satisfaction provides the greatest rewards and - as we shall soon discuss - the greatest potential for self validation of worth of the supplier of any of the three levels. Competition is "dog-eat-dog" at the "need" level, and for suppliers there is a high risk of de-validation, for - after all - many other suppliers can provide what the supplier lodged at this level

can provide, including the needed quality. Price and intangibles often determine one's position in such a capability situation. Survival is not assumed for competitors at this level, where going out of business equates psychologically to death, the ultimate de-validation of self worth. The "wants" level of satisfaction is where most market competitors are, and the risk of being dislodged from one's niche (providing more "wants" for economic or equivalent psychic compensation) is continuous. But at least one can search for and create a niche, though many of the terms of the engagement are dictated by market forces and peer competition. "Creating the market" (The "Delights" Level) is the place to be. All world class quality suppliers have their sights set on this level. Our respondents in this research have told us that the greatest "satisfaction" as a supplier comes from mastering customers <u>and</u> ones own products/services and processes to the extent that one can define the future and then create it. Thus, the drive in the supplier world is ever toward the provision of "delights" and its concomitant customer (<u>and</u> supplier) satisfaction.

Customers, on the other hand, continuously seek to drive delights <u>down</u> the staircase to the lowest ("need") level. Literally, today's delight is tomorrow's want is next week's need. Everyone must have what delights others, for in the delight level of satisfaction is the greatest validation of self worth, the invention of product or service for self. Our respondents told us that if a peer were being "delighted," they wanted to be "delighted" also. Such innovations quickly became part of <u>other</u> quality agreements and soon became "wants" for many, and--ultimately--needs. Pity the poor competitor at the need level of satisfaction. The ante is continually being raised.

Thus, even though the customer-supplier respondents in our sample were having their stated needs and--in some cases--wants met through enactment of customer-supplier agreements, and were "satisfied," their <u>level</u> of satisfaction varied. Likewise, the quality agreements contained both needs and wants in many cases, said our respondents. And the evolution of many agreements included "delights" not envisioned at the time of the original agreement by either customer <u>or</u> supplier. Thus, these variants can be seen to provide a plausible explanation for the statistical variance of the reported results with respect to both full delivery of the agreed-upon quality factors and the accompanying satisfaction of <u>both</u> customer and supplier.

<u>Motivation to be Satisfied</u>

Personal precursors to satisfaction include: environmental influences (including cultural conditioning and goal establishment); experience, group dynamics (bionics); paradigms (perceptual frames and selective perception); needs; values; species specific factors (including genetics);

conation; physiological influences; etc. Figure 4 provides an arrow diagram representation of very complex phenomena that are outside the boundaries of the subject of this paper. However, the collective influence of these framing forces cannot be ignored.

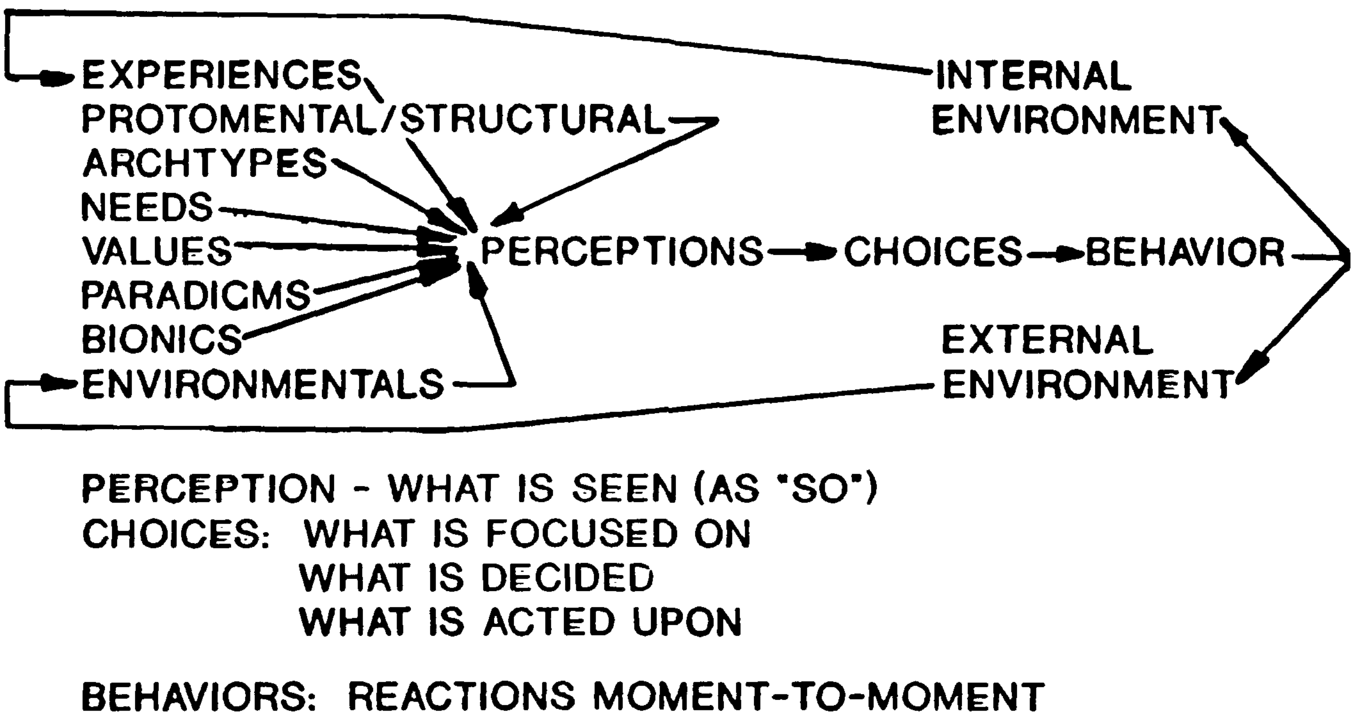


FIGURE 4

Central to an understanding of the satisfaction dynamic is the concept of compensation. Compensation in its essence is much more than economic; it is psychological, and--interestingly--psychometric. Applying Vrooms theory to the issue of compensation in a customer-supplier agreement and thence to the motivation to be satisfied may provide a framework for both strategizing this motivation and quantitatively determining it's strength. What follows is a discourse shared with our research respondents and experientially validated by them as they framed their success (and non-cited

failures) with customer-supplier quality agreements.

Vroom said that there are three components to the motivation to do anything (i.e., to do is to make a choice or change, then behave/act; in this context, doing nothing equates to "doing" or "behaving," moment-to-moment). These three components are: (1) expectancy; (2) valence; and (3) instrumentality, and the theory (Expectancy Theory) states that one's level of motivation is a product of the three components.

Definitions of these three components are shown in Figure 5, below.

<u>EXPECTANCY (E)</u>: Examination leading to the self-perceived probability $P_s(E)$ that a potentiated behavior/action will lead to ascertained performance (performance can be equated to "success," as defined by the individual).

<u>VALENCE (V)</u>: Examination leading to the self-perceived degree of alignment of a potentiated action/behavior with: (1) one's needs; and (2) one's values (behaved priorities).

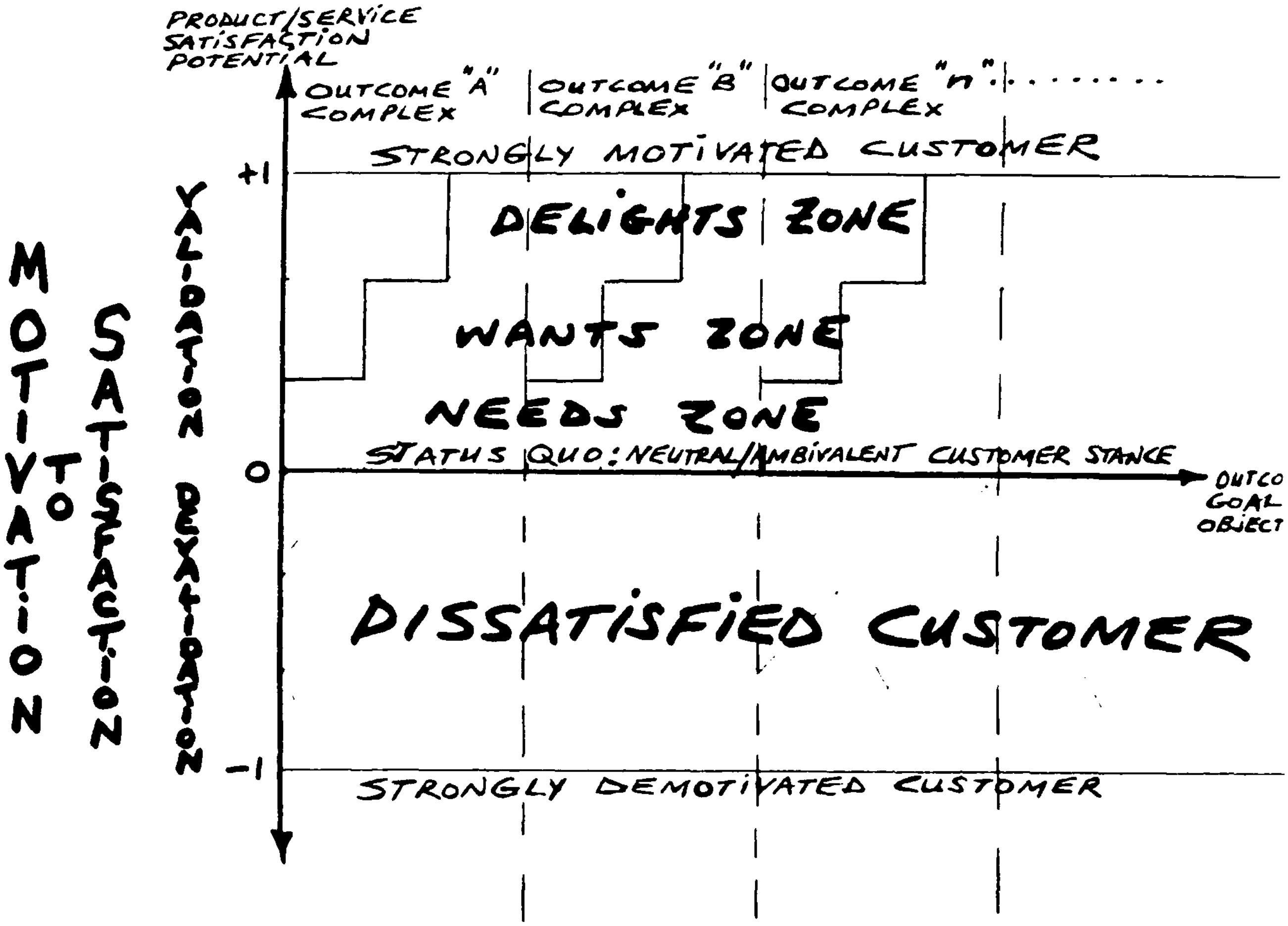
<u>INSTRUMENTALITY (I)</u>: Examination leading to the self-perceived probability $P_s(I)$ that a potentiated behavior/action will have one or more ascertained outcomes (such as reward or punishment), both valence-derived/psychological (intrinsic) and physical/external (extrinsic).

<u>FIGURE 5 - VROOM'S THEORY</u>

Thus, if Motivation = M, then $M = (E)(V)(I)$ and $M = P_s(E) \times V \times P_s(I)$.

Both $P_s(E)$ and $P_s(I)$ can vary between 0 and 1, and Valence (alignment) between +1 (totally aligned) and -1 totally opposed. Classical need theory is subsumed in the Valence component. Thus, an act totally aligned with the dominant need in one's need complex (Maslow) can be said to have a valence of +1, while the same act, opposing one's behaved value system, would have a valence of -1. Multiplying those component values together gives us a potential valence between +1 and -1, (-1 in the case cited here). When multiplied by $P_s(E)$ and $P_s(I)$, the product yield a psychometric measure of motivation, and hence the motivation to be satisfied. Figure 6 refers.

CUSTOMER ACTION MOTIVATION/SATISFACTION PROFILE



NOTE: VALENCE IS DETERMINED FROM A PANOPLY OF WEIGHTED VALUES, BOTH POSITIVE AND NEGATIVE. THE VALUES (WITH WEIGHTS) ARE DETERMINED AND ASSESSED, GIVEN A SIGNED VALUE, NORMALIZED, AND THEN MULTIPLIED BY EXPECTANCY (PERCEIVED) AND INSTRUMENTALITY (PERCEIVED) PROBABILITIES TO YIELD A MOTIVATION (AND POTENTIAL SATISFACTION) LEVEL FOR AN OUTCOME OR OUTCOME COMPLEX.

FIGURE 6

The Role of Self Validation in Satisfaction

Underlying each of Vroom's components is a unifying concept called validation of self worth. Our respondents told us that they perceived themselves as "worth more" if they perceived that the quality agreement they have negotiated is "enactable" (supplier) and that the quality factors will accrue to the recipient (customer). They are self validated in their worth because the time, energy, and personal investment they made paid off; i.e., was not wasted. They are more likely to be satisfied because their self perceived probability of success (i.e., satisfaction) is high.

The valence of successful customer-supplier quality agreements is positive because: (1) the behaved values (priorities) of the negotiants are manifest in the agreement and its behaved enactment, and the needs (psychological as well as economic) are in the negotiated conditions. Fulfillment of such agreements validates the negotiant's self worth in the same manner that doing anything aligned with ones needs and values is more self validating than doing something opposite to one's needs and values (wherein we are de-validated and demotivated).

The instrumentality of successful customer-supplier quality agreements yields a high self perceived probability of expected outcome precisely because of the conditions inherent in the process elements most often cited by our research sample. It is more self validating to achieve outcomes as expected rather than have those same outcomes rendered uncertain by a lack of the very process elements addressed in the successfully enacted customer-supplier agreement. Thus, applying quality theory to design known performance into transformation processes yields not only higher instrumentality but also greater validation of self worth; we are less validated or even de-validated by deficiency-dominated surprises.

Summary

We have thus come to tentatively conclude that behind the terms of customer-supplier agreements and the precursor behavioral and physical circumstances of their negotiation and enactment is the critical factor of self worth, and the opportunity for self validation of this self same worth in the agreement. Our research has led us to conclude that satisfaction is a self validating act. As such, its conditions can be strategized. The behavioral change that is the transition from dissatisfaction to satisfaction can be made more probable if: (1) customers, suppliers, and managers/leaders will establish conditions that increase participant self perceived probability that satisfaction from a customer-supplier agreement can be achieved; (2) customers, suppliers and managers/leaders formally assess the behaved priorities (values) and dominant needs (psychological) of the participants (i.e., each other) in the negotiation and enactment processes. Moreover,

they must develop strategies and agreement conditions to insure that enactment will be in consonance with the values and psychological needs of the participants; and (3) customers, suppliers, and managers/leaders, by virtue of inclusion/application of the customer-supplier agreement process elements discussed in this paper, must negotiate and then engage to ensure that the outcomes of the enactment are, indeed, satisfying and self validating. These outcomes must accrue to both customer and supplier by virtue of the high (self perceived) probability of their achievement. Customer satisfaction is thus seen as an outcome of not only the fulfillment of a quality agreement but also as a consequence of a carefully structured and orchestrated strategy to create the conditions leading to the highly probable consequence of the perception of the increased self-worth of both customer and supplier; all this within the enveloping framework of a customer-supplier interaction whose dimensions are only now becoming clear to us.

Bibliography

1. Maslow, Abraham; Motivation and Personality, Harper and Row, 3rd Ed., 1987.

2. Vroom, Victor H; Work and Motivation; J. Wiley and Sons, 1964.

3. Vroom, Victor (with Arthur Jago); The New Leadership: Managing Participation in Organizations; Prentice Hall, 1988.

4. Bion, Wilfred; A Theory of Group Behavior; Tavistock Clinic; Unpublished Monograph.

5. Juran, Joseph M; Juran on Planning for Quality; Free Press London; Collier MacMillan, 1988.

6. Deming, W. Edwards; Out of the Crisis; MIT Center for Advanced Engineering Study, 1986.

7. Ishikawa, Kaoru; What is Total Quality Control?; The Japanese Way; Prentice Hall, 1985.

8. Denton, D. Keith; Horizontal Management: Beyond Total Customer Satisfaction; Lexington Books Toronto; Maxwell MacMillan Canada, 1991.

9. Hayes, Bob E; Measuring Customer Satisfaction: Development and Use of Questionnaires; ASQC Quality Press, 1992.

INNOVATIVE APPROACHES TO CREATING, ALLOCATING, AND IMPLEMENTING AWARD FEES IN SYSTEMS ACQUISITION

Capt Gregory A. Garrett, USAF, CPCM
and
LTC Alan S. Gilbreth, USA

ABSTRACT

The philosophy of providing contractors an award fee is based upon the premise that the potential improvement in the quality of contract performance offsets any additional cost to the contract. How one establishes and allocates fee on an Award Fee contract is critical to obtaining the best performance at the most significant times. Put another way, is the government motivating the contractor at the right time for the most efficient cost? The focus of this article is to describe how proper application of base fee, award fee, and rollover concepts can be implemented through a variety of approaches. This article examines the innovative use of award fees in the F-22 (Advanced Tactical Fighter) Program Cost-Plus-Award-Fee (*CPAF*) contract, and in the Increased Performance Engine Program Firm-Fixed-Price with an Award Fee (*FFP/AF*) contract.

INTRODUCTION

Contracts containing award fees often result in better communications than other types of contracts between the government and the contractor and greater contractor motivation to achieve exceptional contract performance. These attributes are normally associated with the process of monitoring and evaluating contractor performance. The creation and allocation of fees on award fee contracts, which are linked to the performance evaluation process, are seldom viewed as critical communication and motivation tools. Rather, many organizations primarily focus on the subject/objective aspects of the evaluation process and fee determination.

The philosophy of this article is to describe how proper application of base fee, award fee, and rollover concepts can be implemented through a variety of approaches. This article examines the innovative use of Award Fee in the F-22 Program Cost-Plus-Award-Fee contracts, and in the Increased Performance Engine Firm-Fixed-Price with Award Fee (*FFP/AF*) contracts.

ESTABLISHING THE FEE POOL

A Cost-Plus-Award-Fee contract is a cost-reimbursement type of contract that provides for a total fee consisting of (a) a base amount (which may be zero) fixed at inception of the contract and (b) an award amount, based upon a judgemental evaluation by the government, sufficient to provide motivation for excellence in contract performance (FAR 16.305). Thus, the fee pool on a CPAF contract may consist of both a base fee and an award fee or, just an award fee. When establishing the fee pool on a CPAF contract, the first step should be to determine the maximum fee pool for a given effort.

In order to calculate the maximum fee pool, one must obtain an estimated cost for all of the work required within-the-scope of the contract. To ascertain the estimated cost of a proposed contract, the buying activity may rely on the contractor's proposed cost and/or the buying activity's estimated cost. In the Department of Defense (*DOD*), contract cost-estimating techniques vary greatly. The DOD uses contract cost-estimating techniques which range from detailed cost analyses conducted by multi-functional government teams, (i.e., Should Cost Reviews), to contract cost estimates based upon historical

costs of similar items and/or "grass-roots" engineering estimates. The type of cost estimating technique is, or should be, dependent upon the size, complexity, and other critical aspects of each contract action. Whichever technique may be used, it should be documented as thoroughly as possible.

Once an estimated contract cost is developed for a planned government procurement, under a cost-reimbursement type of contract, it should be multiplied by the applicable statutory limit imposed by FAR 15.903, which includes the following fee limitations for the respective types of effort:

(a) Research and Development (*R&D*) -- 15% of estimated cost,

(b) Production and/or Modifications -- 10% of estimated cost, or

(c) Architect and Engineering (*A&E*) -- 6% of estimated construction cost.

The result of the above calculations represent the maximum (allowable) fee pool which a contractor could possibly obtain for a given government contract.

However, there is no rule which requires the government buying activity to establish the maximum (allowable) fee pool as -- "The Fee Pool" -- for the proposed contract. In fact, all buying activities should consider numerous other factors prior to establishing a fee pool, including: available funding; complexity of the effort; proper incentive (risk vs. Return-On-Investment (*ROI*)); and the amount of the base fee, if any.

Clearly, there is no single approach required by the FAR for establishing a fee pool for a CPAF contract. Rather, one must logically develop an approach based upon rational business sense. We suggest the following three-step basic approach, discussed above, and outlined below:

(1) Develop a "sound" estimated cost for the proposed effort.

(2) Multiply the estimated cost times the applicable fee limitation (FAR 15.903).

(3) Then, consider all other factors which are pertinent to fee determination (i.e., available funding, complexity of the effort, ROI, and amount of base fee).

ESTABLISHING THE BASE FEE

As stated earlier, a base fee on a CPAF contract is a fixed-fee that is established by the buying activity upon contract award. A base fee is incrementally paid to the contractor regardless of its performance on the contract, so long as the contract is not terminated. On government cost-reimbursement type contracts the actual payment of a base fee typically accompanies a contractor's monthly reimbursement (by the government) for "best efforts" of actual contractor expenses. Simply knowing what a base fee is and how it is paid is good, but knowing how to determine a base fee amount is better!

In the following discussion, we have identified three common concepts to determine an appropriate amount of base fee (which may be used) for CPAF contracts. Further, we have identified each of these concepts for ease of discussion. These concepts have been used by various government buying activities to determine an appropriate amount of base fee for CPAF contracts.

(1) Marginal-Performance-Level (*MPL*) Concept

Inherent in this concept is the idea that base fee is established with a particular quality or level of performance in mind. Base fees are established taking into consideration the various profit analysis factors covered by FAR, but in an amount commensurate with that level or quality of performance categorized as minimum acceptable.[1] The MPL concept, to determine the amount of base fee, has been used by NASA and other

government buying activities for nearly 30 years. This concept contains no preset limits to the amount of base fee.

(2) **Unallowable Cost Off-set** (*UCO*) **Concept**

The DOD FAR Supplement (*DFARS*) 216.404-2 (c)(2)(B) states, "The base fee shall not exceed three percent of the estimated cost of the contract exclusive of the fee." The DFARS does not provide the rationale for why this limit is required on DOD contracts; however, through our research we have concluded that several financial aspects caused the development of this UCO concept. One of the most significant financial aspects, considered vital to the establishment of the UCO concept, was and is the business strategy of all contractors to offset unallowable costs which they incur on government cost-reimbursement types of contracts.[2] Typically, Aerospace contractors have had two to three percent of their contract costs deemed unallowable as a result of government cost accounting standards and audits.[3] Thus, many contractors will not agree to enter into a cost-reimbursement type of contract unless they are assured a minimum fee of two to three percent of the estimated cost. The government under the UCO concept would provide contractors a minimum base fee guarantee up to the DFARS limit of three percent to offset contractor unallowable costs, thereby preventing a contractor financial-loss situation.

A base fee of more than three percent is possible but requires a DFARS deviation. This base fee is paid to a contractor even if the contractor's performance is considered by the government to be submarginal.

(3) **Zero-Base-Fee** (*ZBF*) **Concept**

During the past ten years, many government buying activities have established a ZBF concept or policy. The ZBF concept is based upon the assumption that eliminating a base fee the total fee pool, (consisting solely of an award fee), would provide a greater incentive for contractors to achieve superior performance. A ZBF policy was used by the Air Force Systems Command (*AFSC*) buying activities for many years.[4]

When examining these concepts to determine the amount of base fee, it is obvious that the MPL concept provides the contractor with the largest possible base fee, while the ZBF concept provides none. Therefore, the UCO concept is often considered to be a fair and reasonable compromise to determine a base fee amount. However, the UCO approach, as modified by the DFARS 215.974, has the following three constraints which appear quite clear, yet are often misused and/or misunderstood.

(1) DFARS 215.974(b) states:

> In developing a fee objective for CPAF contracts the contracting officer shall not use the weighted guidelines method or alternate structured approach.

This requirement seems very definitive, yet despite its clear wording some major defense buying activities have for years provided CPAF policy guidance to their buying offices to use an alternate structured approach to the DD Form 1547 (Weighted Guidelines Method) in order to determine the amount of fee on CPAF contracts (without obtaining a DFARS deviation).[5]

(2) DFARS 215.974(c) states:

> Apply the offset policy in 215.973(b)(2) for Facilities Capital Cost of Money (*FCCM*) -- DD Form 1861, i.e., reduce the base fee by the lesser of one percent of total costs or the amount of facilities capital cost of money.

The rationale for reducing the base fee in this manner is provided in DFARS 215.973(2)(ii):

> This adjustment is needed for the following reason: The values of the profit factors used in the weighted guidelines method were adjusted to recognize the shift in facilities capital cost of money from an element of profit to an element of contract cost (FAR 31.205-10) and reductions were made directly to the profit factors for performance risk.

Many people in the contracting community interpret this paragraph to mean that there is a relationship between award fee and DOD profit policy. This is incorrect. The commonality between these two DFARS is in the treatment of FCCM, not DOD profit. This interpretation is consistent with the guidance contained in DFARS 215.973(2) and 215.974(c) and, is also consistent with the first constraint discussed.

There is still one more question concerning the application of the offset policy for FCCM. Does one reduce the base fee by the lesser of one percent of total costs or the amount of FCCM -- before or after one applies the three percent limit required by DFARS 216.404-2(c)(B)? Based on our research with various DOD representatives, we have determined that there are no official documents (i.e., regulation, policy, etc.) that deal with this question. It is, therefore, subject to interpretation. It is our view that the interpretation is not as important as insuring that one does not violate any fee limits (15%-R&D, 10%-Production, 6%-A&E, or 3%-DOD base fee limit). In other words, where one ends up (i.e., not exceeding the limits) is more important than how one gets there (e.g., reducing the base fee -- before or after -- one applies the three percent DFARS limit) as long as one indicates how FCCM was considered in the process.

(3) DFARS 215.974(d) states:

> In developing a fee objective for Cost-Plus-Award-Fee contracts, the contracting officer shall not complete a DD Form 1547.

This is the final statement in DFARS 215.974 and clearly communicates that the use of DOD profit policy is not appropriate in developing a base or award fee objective for CPAF contracts.

These three additional constraints imposed by DFARS to the UCO approach to determining a base fee have increasingly raised questions from both contractors and government personnel as to their exact intent and applications for CPAF contracts. As discussed above, there is no single, best approach to determining a base fee for a CPAF contract. In fact, determining a base fee for a CPAF contract is largely dependent upon the government buying activity's specific requirements and/or policies. The real challenge to CPAF contracting is in the creation of the Award Fee -- How much is enough?

CREATING AN AWARD FEE

For years major defense buying activities have provided guidance to their buying offices to use objective methods in order to arrive at either the size of the award fee pool or the amount of the award fee determination on CPAF contracts. In many instances, this was manifested in the use of weighted guidelines or an alternate structured approach for these determinations. DFARS 215.974 clearly states:

> In developing a fee objective for CPAF contracts the contracting officer shall not use the weighted guidelines method or alternate structured approach.

This paragraph further states that:

> contracting officers shall not complete a DD Form 1547 (Weighted Guidelines Method).

The use of weighted guidelines, or an alternate structured approach to arrive at

either the size of the award fee pool or the amount of an award fee determination on a CPAF contract, is inappropriate because it is a misapplication of the DOD profit policy.[6] Equally important, the use of totally objective methods to arrive at the award fee pool or award fee determination is a contradiction of the concepts that underlie and support the use of CPAF contract. Flexibility is needed to arrive at both an award fee pool and award fee determination that suit the circumstances of a particular procurement.[7]

While there is a need for flexibility in the determination of an award fee, there is also a need for consistency in the process. Consistency and flexibility are not exclusive of each other. Award fee ratings must be clearly related to the available award fee pool. Consistency does not mean using an unalterably structured approach. Rather, it means clearly defining the subjective / objective elements of the flexible approach one is using. *Defining your philosophy* in the determination of award fee is beneficial to both the contractor and the government.

The description of how one will create and administer an award fee is the essence of communications. While there should be flexibility in the application of the philosophy, the philosophy itself should be consistently applied throughout a buying activity. The consistent application of an award fee determination will improve communications and have an impact on the entire contracting cycle from the request for proposal to the completion of the contract effort.

The authors will discuss a philosophy of consistency in award fee ratings that can improve the communications between the government and the contractor and better motivate excellence in performance. The point of this discussion is not to relate that any one philosophy represents a preferred approach, but that a buying activity should have a clearly defined philosophy and broadly communicate that philosophy to their personnel and potential sources.

DEVELOPING STANDARDS FOR EACH CRITERIA

The first step in achieving a philosophy of consistency in establishing award fees is to develop performance standards for each evaluation criterion. These performance standards should be written so they describe what is required to meet the terms and conditions of the contract. Contractor performance normally should not be rewarded at or below this standard. Performance standards must relate to an adjectival rating/grade. Which adjectival rating (e.g., satisfactory, marginal, good) one uses is not as important as how clearly it is described.

This concept is consistent with DFARS 216.404-2 which states that:

> Normally, award fee is not earned when the fee-determining official has determined that contractor performance has been submarginal or unsatisfactory.

CONSISTENCY IN CREATING AWARD FEE

ESTIMATED COST: $100 MILLION
MAXIMUM FEE POOL (R&D): 15% OR 15,000,000
BUYING ACTIVITY AVG. FOR CPFF: 7.5% OR 7,500,000

EXAMPLE #1:
BASE FEE: 3% $3,000,000

			AVG. FIXED FEE		MAX. AWARD FEE
AWARD FEE RANGE:	0	TO	$4,500,000 (37.5%)	TO	$12,000,000 (100%)

EXAMPLE #2:
BASE FEE: 0%

			AVG. FIXED FEE		MAX. AWARD FEE
AWARD FEE RANGE:	0	TO	$7,500,000 (50%)	TO	$15,000,000 (100%)

Figure 1

Figure one

There should be one adjectival rating level that relates to the description in the DFARS when an award fee is not normally given. In other words, meeting the terms and conditions of the contract should not entitle the contractor to an award fee. Exceeding the terms and conditions of the

contract is *excellence* and should be rewarded. Proper use of developing standards for criteria bring some objectivity into a subjective process. Most organizations that use CPAF contracts accomplish this step to some degree. Thus, the process of developing clear and consistent levels of evaluation standards for contractor performance improves the award fee process.

RELATING THE STANDARDS TO AN AMOUNT OF AWARD FEE

The next step is to relate the performance described in the adjectival rating for standards to an amount of fee. Doing this does not reduce the flexibility of award fee determinations. It simply clarifies an organization's philosophy for creating and determining the amount of award fee. Using your buying activity's average Cost-Plus-Fixed-Fee (*CPFF*) contract communicates one's award fee philosophy. Of course, in a *CPFF contract the government* assumes the risk, namely, the award fee. Nevertheless, it is still an excellent tool for comparison. Figure One illustrates how a particular philosophy of award fee determination can be related to a buying activity's average CPFF percentage.

In Figure One, the buying activity has determined that if the contractor meets the terms and conditions of the contract in a CPAF contract, it should earn essentially the same fee as they would in a CPFF contract. The estimated cost is $100 million with a maximum fee pool of 15 percent (R&D), or $15 million. The buying activity's average CPFF contract is 7.5 percent of the $100 million estimated cost, or $7.5 million. Example number one in this Figure has a base fee of three percent of the estimated cost, or $3 million. If the contractor achieves a rating that equates to meeting the terms and conditions of the contract, it will earn approximately the same as it would under a CPFF contract. This would amount to $4.5 million or 37.5 percent of the available award fee pool of $12 million.

In example number two, there is no base fee so the award fee pool for meeting the terms and conditions of the contract would be $7.5 million or 50 percent of the award fee pool of $15 million. The approach one would use with award fee only does not have to be the same, nor are the authors implying that one should structure an award fee philosophy that pays a contractor the same amount for meeting the terms and conditions of a CPFF contract as a CPAF contract. The focus of these examples is not to espouse a philosophy of award fee determination but to illustrate the importance of clearly communicating one's award fee philosophy and, how that communication will motivate performance excellence.

This step in creating an award fee is not done well in most buying activities. Contractors generally try to determine each organization's *philosophy of award fee* determination by intelligence and past experience. This is usually satisfactory for contractors that know the particular buying activity, as long as that activity's philosophy does not change and is consistent with its past. It is not beneficial to either the government or the contractor to project possible award fee determinations solely on supposition when an award fee determination philosophy can and should be clearly communicated in such a way that it will motivate contractors to superior performance.

FEE ALLOCATION AND ROLLOVER

Fee allocation and rollover are key motivators for excellence. How fees are structured on CPAF contracts will determine the potential level of motivation. The length of the evaluation period and the amount of award fee available for each period can vary. This is a government decision, but it is proper to seek the contractor's views. Typically the government establishes evaluation

periods from four to six months in duration.[8] This takes into consideration the contractor's desire to shorten evaluation periods so they can recover their award fee more quickly and the government's desire to lengthen the periods, to reduce the administrative burden. Evaluation periods longer than one year generally do not achieve the desired benefits for either the government or the contractor.

The amount of award fee available can vary with each evaluation period, with larger portions made available on evaluation periods in which performance criteria are of greater significance. If a contract contains tests, demonstrations, or milestones, then allocate a certain amount to the event, not to the evaluation period.[9]

Figure Two is an example of how one could allocate an award fee pool. In this example, the authors took a contract with a $100 million estimated cost and multiplied the cost times the statutory limit (percentage) for an R&D contract (15 percent) to achieve a fee pool of $15 million. The award fee pool was then determined by subtracting the base fee of $3 million from the maximum fee pool of $15 million for an award fee pool of $12 million. This example contains five award fee periods of equal length with various amounts of award fee available based on more dollars being allocated to evaluation periods in which criteria were of greater significance. Also, there was an additional $900,000 available to whatever period final acceptance occurred.

Unearned award fee may be carried forward for possible award in subsequent evaluation periods. However, this process, called "rollover," "roll-forward," or "recoupment," should be the exception and not the rule. Rollover has certain disadvantages regardless of how or when it is used. The disadvantages are: (a) it devalues previous periods, and (b) it allows contractors to lower performance in some periods without being penalized. In certain limited situations the advantages to the government of using rollover can outweigh the disadvantages. Potential advantages can be: (a) it would increase the available award fee pool; (b) it would not penalize the contractor for a learning-curve situation; and (c) it could motivate the contractor to correct problems from previous periods.[10] These potential advantages relate principally to deliverable hardware items.

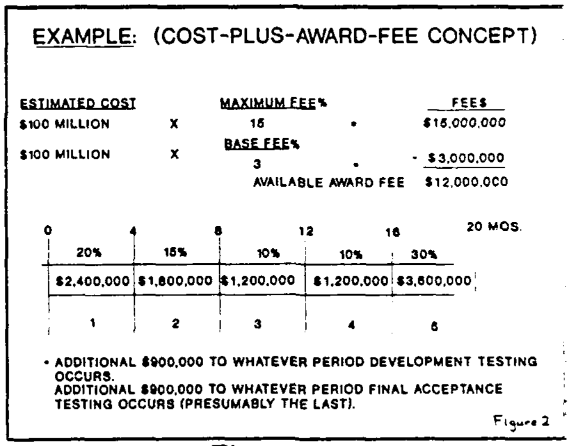


Figure two

Rollover, therefore, might be appropriate in an Engineering and Manufacturing Development (*E&MD*) contract where initial Operational Test and Evaluation (*IOT&E*) was required prior to transitioning into a lower-rate, initial production on another contract. It would be appropriate to rollover an award fee from the period prior to the period in which IOT&E occurs in order to place greater incentive on the period in which IOT&E occurs. The FAR and the government's supplemental regulations permit the use of numerous methods for allocating fees and the use of rollovers, when appropriate, on CPAF contracts if doing so will truly assist buying activities in motivating contractors to achieve exceptional performance.

Implementing Innovative Approaches to Award Fees

The following portion of the manuscript shall examine two distinctly different acquisitions by discussing their respective innovative approaches to award fees, and their respective lessons learned. The specific programs we shall review are the F-22 Engineering and Manufacturing Development contract and the Increased Performance Engine (*IPE*) production contracts. All of these contracts were awarded by Air Force Materiel Command (*AFMC*), Aeronautical Systems Center (*ASC*), and are contractually administered by their cognizant Defense Plant Representative Offices (*DPROs*).

Increased Performance Engine (*IPE*) Award Fee Description

Two IPE production contracts valued at $ 900 million each, were negotiated as Firm-Fixed Price with Award Fee (*FFP/AF*) type contracts. One IPE contract is between AFMC/ASC and General Electric (*GE*), and the other is between AFMC/ASC and Pratt-Whitney. The IPE contacts each contain a maximum fee pool of $2 million per year. The award fee is included to further motivate each contractor to exceptional performance in order to improve safety, quality, reliability, and maintainability of controls and accessories for their IPE. The IPE FFP/AF contracts each have evaluation periods which are six-months in duration. The IPE contracts are scheduled to last from 1 December 1989 thru 30 November 1993. The semi-annual evaluation periods are 1 December-31 May and 1 June-30 November of each year.

The Fee Determining Official (*FDO*) for the IPE contracts originally was the Commander, Aeronautical Systems Center (*ASC/CC*), but was later delegated to the Subsystem's System Program Office (*SPO*) Systems Manager, ASC/SM. The award fee evaluation and fee recommendation to the FDO are made by an Award Review Board (*ARB*) composed of SPO and DPRO representatives from the following functional areas: engineering, manufacturing, contracting, logistics, program control, quality, and others. With these basic facts concerning the IPE contracts, let us discuss four of their innovative approaches to award fees.

IPE Innovative Approaches to Award Fees -- Award Fee Use on FFP Contracts

Seldom has an Award Fee been used on a multi-million dollar subsystem contract in conjunction with a Firm-Fixed-Price type of contract. In addition, when an award fee is combined with a type of contract other than CPAF, the profit or fee already part of the contract serves as the equivalent to the base fee. Thus, the IPE contracts do not contain a typical base fee, as commonly used on CPAF type of contracts.

Few Performance Monitors

The Subsystem's SPO propulsion office managing the government administration of the IPE contracts selected only a few performance monitors in each functional area to provide input to the government's Award Review Board (*ARB*). Typically, contracts of this size and complexity have many more people involved in evaluating the contractor's performance. The Subsystem SPO found that sometimes *fewer* government performance monitors, who are well educated and trained in their functional area and their specific performance monitoring responsibilities, are *better*!

Highly Empowered ARB

The FDO for the IPE contracts has highly empowered the members of the Award Review Board to evaluate, tailor and summarize performance monitors' findings. Even with the best performance monitors, it is possible, (even likely) to have a variety of

opinions when it comes to subjectively evaluating a contractor's performance, no matter how much one objectively structures the evaluation process. The FDO needs an as clear and concise as possible recommendation from the ARB, concerning the contractor's performance versus the Award Fee Plan. Highly empowering the ARB allows the ARB members to segregate the chaff from the wheat and provides the ARB with the flexibility to examine the whole effort from a system perspective, rather than merely reporting functional inputs.

Comprehensive Contractor Documentation of Their Performance

The Subsystem's SPO propulsion office decided, rather than having the government team of evaluators compile data from numerous functionally generated data items (Contract Data Requirements List -- DD Form 1423), that it would be far more efficient and effective to require the contractor to prepare a comprehensive performance information package to submit to the government for evaluation. Requiring the contractors to submit a comprehensive information package documenting their actual performance, versus the award fee plan, accomplishes many objectives, including: encouraging multi-disciplinary solutions, improving management indicators, helping focus the contractor on key issues, helping ensure access to accurate information, and creating a nearly comprehensive (excludes government evaluation) document to support evaluations, should an outside agency ever audit the IPE's award fee efforts.

IPE Award Fee -- Lessons Learned

Despite the use of several innovative approaches and numerous time-tested approaches to award fees, the IPE contracts initially encountered a few all-too-common problems. Remember, "We must learn from our past mistakes, otherwise we shall be doomed to repeat them." The AFMC/ASC Subsystem's SPO propulsion office offers the following five lessons learned:

(1) *Update the Plan (for example)*

Do not be caught with 50% of the award fee allocated in the Award Fee Plan to field performance when you have not fielded the equipment.

(2) *Do Not Be Afraid to Vary the Fee*

Do not be trapped by your previous contractor's performance evaluations. Give the contractor the amount of award fee that the contractor deserves, whether they like it or not!

(3) *Develop Effective Evaluation Standards*

Award Fee evaluations should not vary dramatically based solely upon evaluator personalities. Performance Standards must be established and clearly communicated to the contractor and to all government performance monitors.

(4) *Award Fees Must Have A Message*

The FDO must use the award fee process to clearly communicate to a contractor his/her view of their performance and where improvement is required.

(5) *Round-off Evaluator Scores and be Prepared to Defend Them*

Typically, the ARB summarizes performance monitor inputs but does not always round-off the scores (i.e., 93.5 points. vs. 85-95 points.). Rounding-off evaluator's scores to either point ranges or to an adjectival rating (i.e., Excellent, Good, Satisfactory, etc.) can ease the evaluation process by eliminating non-value-added discussions over point disagreements. If/when evaluator scores differ by more than 20%, you had better reconcile, if possible, the differences; otherwise you will have to defend the validity of the differences to the FDO.

F-22 Award Fee Description

The F-22 program has two Cost-Plus Award Fee contracts. One contract valued at $1.4 billion is between AFMC/ASC and Pratt-Whitney for the engines and the other contract valued at $9.7 billion is between AFMC/ASC and Lockheed for the weapon system. These contracts contain a fee pool of approximately $ 1 billion. The award fee is included to motivate each contractor to exceptional performance. The criteria selected by the SPO are overall progress toward integrated weapon/engine system development, overall schedule performance, overall cost control, and other program considerations. The SPO believes that these criteria encompass the entire effort and ensures that the contractor is motivated to work the complete system rather than to focus on specific areas. The F-22 award fee evaluation periods are six-months in duration (for a total of 17 evaluation periods in engineering and manufacturing development *(EMD)*) which is scheduled to run through 1999. The semi-annual evaluation periods are 1 October-31 March and 1 April-30 September of each year. The Fee Determining Official *(FDO)* responsibility has been delegated to the F-22 Program Director. Now, let us discuss four of their innovative approaches to award fee.

F-22 Innovative Approaches to Award Fees -- Award Fee Philosophy

The F-22 System Program Office *(SPO)* uses an integrated management structure and this structure is reflected in their philosophy of award fee. Essentially, the contractor plans/commits to an executable program and then manages to his plan. The government evaluates and distributes award fee according to how the contractor has performed to his plan. This approach is unique in two aspects. First, it gives the contractor the flexibility to plan the program, then manage to his plan versus the government's plan. Second, full compliance to the plan results in an award of 100% of the fee available that period. Typically, award fee is not paid for just meeting the terms and conditions of the contract, but for exceeding those requirements. However, exceeding requirements in a cost-plus contract can result in additional cost to the government. To ensure no "gold plating" occurs, the F-22 SPO set up the award fee so that 100% award would be granted for total compliance to the contract. The philosophy of the SPO is that when the contractor plans / commits to an executable program and achieves it, then true excellence has been met.

The F-22 SPO uses the adjectival ratings of excellent, very good, good, satisfactory, and unsatisfactory. This is not unusual, but the fact that they have only one adjectival definition for all criteria is innovative. For example, the definition of the adjectival rating of excellent is -- high probability that a quality product will be delivered on time and on budget. This definition applies to all award fee criteria. Usually, a unique definition is written for each adjectival rating for each criteria in an award fee plan.

Base Fee Exceeds DFARS Limitation

The DFARS states that base fee shall not exceed three percent of the estimated cost of the contract, exclusive of fee. The F-22 received approval from the Director of Defense Procurement, Office of the Under Secretary of Defense (Acquisition), USD(A)DP, for a deviation to allow a base fee of four percent. The F-22's award fee is 9% for a possible 13% fee to be earned by the contractor.

Extensive Performance Monitoring

The F-22 SPO approach to monitoring contract performance is that award fee assessments are inseparable from the day-to-day management of the program. Consistent with their integrated management

structure approach, each Integrated Product Team (*IPT*) and each functional office has a performance monitor focal point (*PMFP*). Within these organizations every member is a performance monitor. In addition to the SPO this includes members of the Defense Plant Representative Offices (*DPROs*), Air Combat Command (*ACC*), Air Training Command (*ATC*), and others that are part of the program. Every member provides written input to the appropriate PMFP on specific areas of knowledge. The ATP SPO philosophy is that all government personnel involved in the F-22 program have a voice in award fee evaluations. This high visibility results in no surprises at award fee assessment time if communications are open and frequent. The involvement of the monitors in this approach is much broader than most award fee plans and it is far more detailed and structured.

Expanded Award Fee Documentation

One PMFP from each IPT and each functional office collects and consolidates input from respective areas of the program for use during the evaluation. The PMFP prepares and coordinates monthly reports through the IPT/Functional Director. Additionally, the PMFP prepares and coordinates a midterm briefing at the three month time frame of the award fee period through the IPT/Functional Director. The F-22 award fee branch maintains all official award fee files and database and oversees the administration of award fee procedures. To insure that communications are occurring, feedback to the contractors is conducted monthly. This approach to award fee documentation and feedback is much more comprehensive than is usually found. Typically, there are informal communications going on throughout the award fee period at the monitor level with very little structure. Many government organizations also have a requirement for some midterm informal evaluation of the contractor. The depth and quality of this evaluation varies greatly from organization to organization and contract to contract.

F-22 -- Lessons Learned

The F-22 award fee contracts are off to an early and successful beginning, but there are always areas for improvement. The AFMC/ASC F-22 SPO offers the following lessons learned:

(1) **Do Not Be Afraid to Revise Criteria**

The F-22 SPO determined that their criteria needed to reflect a product emphasis so they changed the criteria. They were not hesitant to change the criteria so that it better met their needs and their desired emphasis. Do not be afraid to change any aspect of the award fee plan if it better motivates the performance you desire.

(2) **Utilize Defense Contract Management Command** (*DCMC*) Support

The F-22 SPO realized the value of DPRO involvement and made a point of reinforcing this. The new DCMC is organized to support their customers, government / military buying offices. The organizational structure of DCMC is composed of three directorates; Contract Administration, Quality Assurance, and Program and Technical Support. Through the FAR delegation process, DCMC can serve as a valuable asset for evaluating contractor performance.

(3) **Write It Down! Write It Down! Write It Down!**

Sooner or later your memory will fail you. It is imperative to keep detailed written records. Be specific in your examples to include the impact of what you are documenting. Put your written records where you can find them.

(4) **Communicate! Communicate! Communicate!**

Frequent and specific communication with the contractor and other government organizations is a must at all levels. There

should be no surprises when there is open communication. Award fee should be a part of daily management of the program.

SUMMARY AND RECOMMENDATIONS

This article has examined the following aspects of award fee contracting; how to develop a maximum fee pool; various concepts for establishing a base fee; different philosophies and actual approaches for creating an award fee; the importance of developing and relating performance standards to an amount of award fee; and some of the concepts and techniques involved in fee allocation and rollover. These issues do not comprise an all-encompassing list of items concerning contracting with an award fee. Rather, this article has focused on some of the less frequently discussed issues of contracts with award fees -- creating, allocating and implementing award fees.

When involved in award fee contracting the authors offer the following recommendations:

Use UCO Concept for Base Fee (For CPAF Only)

This concept for establishing a base fee ensures a contractor that it will be provided a minimum fee guarantee to "offset" contractor unallowable costs, thereby preventing a contractor financial loss situation.

Consistent Buying Activity Award Fee Philosophy

Every government buying activity should have a clearly defined philosophy and broadly communicate that philosophy to their personnel and potential sources. However, remember consistency and flexibility are not mutually exclusive. A consistent buying activity philosophy can and should provide flexibility to arrive at an appropriate award fee pool and award fee determinations that suit the circumstances of each contract action.

Fee Creation as a Motivational Tool for Excellence

There is *no single approach required* by the FAR or DFARS for establishing a fee pool for a contract with an award fee. Whatever approach is used, remember that the purpose for creating the fee pool is to motivate the contractor to excellent performance. To this end we suggest the following approach:

(1) Develop a "sound" estimated cost for the proposed effort.

(2) Multiply the estimated cost times the applicable fee limitation (FAR 15.903), for cost-type contracts.

(3) Then consider all other factors which are pertinent to fee determination (i.e., available funding, *complexity of effort*, ROI, and amount of base fee).

Rewarding Excellence

What constitutes excellence must be clearly defined. When excellence is achieved, it should be appropriately rewarded.

CONCLUSIONS

The use of award fees on government contracts are complex and often controversial. They require a significant amount of contractor performance evaluation by the government. But, simply stated, any contract is a communications vehicle to express an agreement between its parties. Contracts containing award fees provide contractors with numerous avenues to communicate openly with the government during contract performance. Moreover, award fee contracts provide the government with greater input or leverage to motivate contractors to achieve exceptional performance.

END NOTES

1. "Guidance on Award Fee Contracting," *Guidebook,* NASA, June 1989, pg. 3.

2. Cibinic, John Jr. and Nash, Ralph C., *Formation of Government Contracts*, Second Edition, 1986, pg. 777.

3. *Id.*

4. "Award Fee in Systems Acquisition -- A Handbook for Program Directors and Contracting Officers," Air Force Systems Command, 1972, pg. 7.

5. *Id.*, pg. 6.

6. Department of Defense Inspector General Memorandum For Record, "Decision on Disputed Recommendations in *OIG Audit Report No. 91-068*, "Contractor Support at Major Range and Test Facility Bases -- Contractors' Fees," March 21, 1991, Management Position of Eleanor Spector, Director of Defense Procurement, September 11, 1991, pg. 1.

7. *Id.*, pg. 2.

8. *Supra*, Note 2, pg. 788.

9. *Supra*, Note 4, pg. 9.

10. *Supra*, Note 1, pg. 12-14.

CHANGING THE SYSTEM
WHAT ARE THE IMPLICATIONS OF AN ACQUISITION DEPARTMENT?

ABSTRACT

For the past several years there has been a vocal call for a revolution in the way the DOD acquires its major weapon systems. The need for change within the DoD acquisition system has been articulated by a diverse set of individuals who run the gamut across the ideological political spectrum. While the entrenched bureaucracy fights to delay the inevitable, there can be little doubt that there will be significant changes once the Clinton Administration's Defense hierarchy faces the reality of reduced budgets, a shrinking workforce and a new strategy for weapons acquisition which no longer relies upon the production and deployment of systems, but rather the development and prototyping alone. The new reality will force the system to change. Some of this change is already evident in the restructuring of the individual services. Air Force Material Command is a precursor of change that is inevitable. Defense contractors are consolidating and eliminating those divisions that have little or no value added to corporate needs.

If we accept the inevitability (and necessity) of change, what will that change be? Streamlining is a key. If U.S. long term national security needs are to be met, innovative and creative planning will be required. What are some of the recommendations for this systemic change, and what are their implications? One of the more innovative proposals advocates the creation of an Acquisition Service, similar to the other services (Army, Navy & Air Force). This service would be a hybrid of the military and civilian services, with many of the more promising features of each. If the DOD is truly committed to the implementation of the principals of Total Quality Management, then it seems reasonable that there must be major changes in the acquisition process. The military must be removed from all aspects of the acquisition process except from those normally reserved for the customer.

This paper will discuss the basic concept of the Acquisition Service. It will provide a rational explanation as to the costs and benefits of such a significant change along with the statutory and regulatory revisions required. The centralization of the procurement function will not eliminate the abuses that have transpired in the past, however, there will be an inevitable streamlining of the process which can not help but realize substantial savings to the government.

The Clinton Administration is committed to the revitalization of "The views expressed in this article are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government."

The acquisition process. The congress is also committed to a major change. The american public need to be reassured that their tax dollars are being managed in a competent, professional manner. While there is a large entrenched bureaucracy committed to the status quo, even these groups will come to recognize the inevitability of change. It is the responsibility of the professionals within the acquisition workforce to ensure that this change is truly productive.

INTRODUCTION

In the Presidential election of 1992 all candidates ran on the platform of change. This change was to come in a variety of ways. Each candidate had specific and general recommendations which would result in structural

changes to the way the federal government conducts its business practices.

One area that did not receive attention during the campaign was the way the Federal Government contracts with the private sector for goods and services.

Granted, this is a somewhat esoteric subject which elicits little response from the average American. If serious change is to come to government, it must come not only in what the government buys, but also in the manner and the system that it utilizes to accomplish this acquisition.

There is a general consensus that the Clinton administration should reduce the level of expenditures associated with Defense. The nature and size of the threat to U.S. security has undergone a substantial change over the past several years and it is only reasonable to accept a reallocation of the country's resources. This will require a transition from Defense to other social programs (social in this context to include the revitalization of the country's infrastructure; i.e. roads, bridges, transportation etc.). The "Peace Dividend" has become enmeshed in the prevailing wisdom of the day, and most Americans anticipate a large savings in tax dollars from the breakup of the Soviet Union and the conversion of Eastern Europe. President Clinton has emphasized that he will utilize this savings to fund some of his new programs. In his book he promised that "Every dollar we save by downsizing our armed forces and defense industries will be reinvested during our transition to a post-Cold War economy."[1]

As funding is shifted, it is imperative that Defense related industries be accorded the opportunity to retool and restructure in order to become competitive in alternative venues. If we accept the premise that governmental involvement in the transition from a Defense economy to a non-Defense economy is imperative to avoid short-term economic instability, then it is reasonable to ask what changes will be necessary to ensure that this transition does not seriously impact our capabilities to protect vital U.S. strategic interests.

What can be done to ensure that these interests are not sacrificed? One area that may offer potential savings comes in the form of restructuring the DoD. Services are evaluating mission requirements from the perspective of substantial downsizing. If possible, there will be a consolidation of missions, with a concurrent reorganization of commands, possibly even extending to the Service level.

President Clinton has stated that he intends to cut $60 Billion from the DoD budget over the first five years of his Administration(s?). If he is truly *committed to the funding* of those major weapons programs that he indicated during the campaign, then, as I see it, he must make up this savings in one of three ways.

First, he can withdraw troops currently stationed overseas, (Europe & Korea predominantly). Second, he can systematically drain the O&M and Personnel accounts, resulting in massive layoffs of defense workers and, most likely, a return to the "hollow forces" that existed prior to the Reagan buildup. Finally, he can attempt, through reorganization and attrition, to accomplish more with less and reduce the alleged fraud, waste and abuse that many (from the Grace Commission to Ross Perot) have claimed exists in the DoD bureaucracy.

If he attempts to remove troops from overseas, he risks the possibility of destabilizing the international environment. This reduction would ulti-

mately reduce our ability to influence events in some of our most vital strategic interests. In the event of a military conflict in these areas, he would be forced to decide between forsaking allies, and reintroducing American troops - possibly risking American casualties. He has promised to "call on our allies to shoulder more of the defense burden"[2]. He also has promised to "Meet our NATO responsibilities in Europe with 75,000 to 100,000 U.S. troops, rather than the 150,000 troops now proposed by George Bush"[3] Given the increasing volatility of this region Mr Clinton has legitimately backed off somewhat from his initial position. In light of his problems with his Vietnam record, this would be a very high risk scenario if it were played out during the first few months of his presidency.

The risk associated with reducing personnel and readiness is obvious. There would be significant resistance to this policy if it results in the prolonged unemployment of those workers who faithfully served in the defense of this country for forty years. Not only would there be negative reaction to this policy, but there could be severe consequences upon his ability to initiate new economic programs. Reduced tax revenue accompanied by increased unemployment payments would mean the loss of a good portion of the peace dividend.

Further, if certain regimes perceived some advantage from their ability to use military force, they would be more prone to do so if they perceive the major powers to be incapable or unwilling to use force to deter them - see Iraq. It is most certain that, in my view, the European powers will not have the capability (or the credibility) to project power, even to areas of vital interest to both themselves and the U.S. Recent history has shown that most of the European countries with the ability to project power have been incapable or unwilling to do so without U.S. leadership. Nature (and international politics) abhors a vacuum. When we disengage from our role as a major power, that role will be assumed by some other country, perhaps one whose interests do not coincide with those of the U.S.

One ancillary question is whether we will be able, or willing to protect Israel against potential adversaries in the middle east? Even more important is the matter of Israel's perception of that question. They **have** demonstrated a credibility to use force when they have perceived their vital interests to be threatened. Given the current buildup of arms in the middle east, it is most certainly not in our interest to have a confrontation between Israel and her Arab neighbors.

If we have learned anything from the study of national security, it is that there must be both capability and credibility to ensure that vital interests are protected and aggressors are deterred from acting based upon the basis of force and violence. If we reduce our force posture to a "hollow shell", we will be in danger of losing both the capability to respond, along with the credibility that we will respond to those situations which we may deem vital to our national interests.

It would seem apparent then that the most reasonable course of action would be to attempt to realize savings by increasing efficiencies, while concurrently attempting to eliminate much of the fraud, waste and abuse in the DoD.

In my opinion, one area that offers potential savings through efficiencies is that of DoD restructuring. This is currently in practice in the private sector of the Defense commu-

nity and it has demonstrated significant results in terms of instant savings. Companies are recognizing that opportunities for Defense business will be reduced in the future. They are consolidating some divisions and eliminating others. Theoretically, this will result in a more efficient and streamlined organization. One theory of management that has gained acceptance for assisting DoD policymakers in this reorganization is that of Total Quality Management or TQM.

TQM is currently the official management initiative of the DoD. It has been inculcated into the defense community and has basically been accepted as a positive vehicle for change.

In accordance with the principles of Total Quality Management, how do we accomplish this force reduction while continuing to ensure that national security needs are accommodated?

Total Quality stresses the principal of continuous process improvement. One process which offers significant potential for savings is that of weapons acquisition. The structure that has served this country so effectively for the past few decades is in need of an overhaul. In spite of various attempts at reform, there are many changes that may be implemented to ensure that quality products are acquired at reasonable cost in a timely manner.

There was some recognition that change would be necessary in the Air Force through the creation of the Air Force Material Command. The purpose of this consolidation was to present "one face" to the customer and provide "cradle to grave" support for weapon systems. To quote the Air Force Chief of Staff "About five years ago, Air Force Systems Command began a new quest for total quality leadership. Our customers were demanding it and our people had many ideas on how to improve our processes. Under the Defense Management Review, these commands continued streamlining and integrating many elements of our business, moving closer to a single, uniform acquisition and support process for the total life cycle. As their organizations transitioned and world events unfolded, it became clear that our smaller, more flexible and responsive Air Force could be better served by a single command charged with supporting all the equipment needs of the warfighting commands. The single supporting command will be named the Air Force Material Command."[4] This was an admirable attempt by the Air Force to implement change in an orderly, structured manner.

Unfortunately, to some observers, it also represented an attempt, by the Service, to avoid major restructuring. Restructuring that is critical in a Clinton Administration that is committed to change.

I believe in the principles espoused by General Yates and I am committed to their implementation. I believe that the Air Force simply did not go far enough with their initiative. Had the OSD taken this initiative and implemented it across the services, I believe there would have been a significant savings realized in the cost and efficiency of the DoD acquisition system.

If we take the concept of providing a single face to the user, and extend it to the different processes by which each individual Service acquires weapon systems we must see the incongruity herein. The Services should be able to provide this basic feature to all Defense customers rather than relegating this feature on a Service only basis.

<u>BODY/TEXT</u>

What is the mission of DoD Acquisition? The Air Force Material Command has stated the AFMC mission is to "provide an Air Force that, with the other armed forces, can:

- Preserve the peace and security of the United States,
- Provide for its defense,
- Support national policies,
- Implement national objectives, and
- Overcome any nation responsible for aggressive acts that imperil its peace and security (sic)

Teamed with the Army, Navy and Marine Corps, the Air Force is prepared to fight and win any war if deterrence fails.[5]

If we accept the principles espoused by this mission, what are some alternatives in process improvements that will assist the Air Force (and the DoD in general) in successful implementation of that vision?

First, and foremost, I believe that a major overhaul in the acquisition process is necessary if we are to continue to provide the quality products necessary to insure that our fighting men and women will have systems with technological superiority built into them. I would submit that the changes to date represent an evolutionary approach toward change, whereas I believe that a revolutionary approach is required.

Why is revolutionary change necessary? And why is it necessary today? Under President Clinton the DoD will experience a rapid downsizing that is unprecedented in U.S. history outside of the conclusion of major wars. This change is inevitable and it will be substantial. If we are committed to a healthy economy, we must recognize that it is ultimately in our interest to redirect tax revenues from defense to other national programs that have higher priority.

Numerous studies have been conducted by blue ribbon commissions and Presidential Task Forces into ways to improve the weapon acquisition process. A commission has only recently completed their evaluation into the regulatory changes that might serve to expedite the process and encourage commercial companies to participate in DoD business. While these studies are commendable, they too often fail to grasp the magnitude of the problem nor are they able to provide the "big picture' recommendations that will be necessary in the coming years.

In order to assess the need for change we should address the matter of viability. How likely is it that the military services will be able to buy all the systems that they currently have in process given the reduced funding that will be experienced in the coming years? Is there excessive redundancy within the Services and between the Services both in regard to the administration of weapons acquisition and the requirements process itself? Or, to put it more simply, do we have a need to restructure the system, given the reduction in threat and the reduction in dollars?

I believe the answer to these questions is yes and I also believe that we can not afford to wait until it becomes necessary to cancel weapons programs due to lack of funds before we acknowledge this reality. The Department of Defense must take the initiative to forestall this eventuality. In order to accomplish this, major changes must take place within the DoD acquisition system.

What are these changes, and how will they be implemented? There are a number of changes currently in process, however additional, substantive changes must be

implemented, and soon.

One major change that could be implemented is the creation of an Acquisition Service within the Department of Defense. This Service would be responsible for the acquisition of all weapon systems by the DoD. This approach has been advocated by some in the defense community. Mr Bernard Schwartz, CEO of Loral Corp, in a speech to a conference on the Defense industrial base advocated "The elimination of redundancy in military procurement by consolidating the four service acquisition bureaucracies into one"[6]

The creation of this Service would be entirely consistent with the reorganization that many DoD contractors are undergoing. As I discussed above, the consolidation and elimination of redundant functional organizations within DoD corporations is aimed at streamlining these companies and ensuring their competitiveness in a shrinking market. These restructuring are also aimed at transitioning from defense related business to other non-defense business.

Why shouldn't the DoD take a page out of the private sector and restructure into a more efficient organization? Business as usual is no longer acceptable given the new reality.

The Acquisition Service would effectively be a hybrid between the Civil Service and the Military Service. In my opinion, it is critical that we remove the military from the acquisition business. This needs to be done not because they are not extremely capable, dedicated, hard-working acquisition employees. Rather, it is necessary because it is simply not fair to have them serve two masters. They must decide, in many cases, whether it would be more beneficial to their career to fulfill military or acquisition career responsibilities. By this I mean that there are multiple demands upon their time. They currently must meet military standards such as professional military education which may make them a better military officer, but most certainly adds little to their business acumen. They also must meet professional acquisition requirements such as the Defense Systems Management College or the Air Force Institute of Technology (AFIT). Many officers are forced to choose between these two options. In an Acquisition Service, professional development would have the highest priority in an individual's career development.

The Acquisition Service would also help avoid much of the inter-service rivalry which can result in redundant weapon systems. It would be similar to the type of system that was recommended by the Assistant Secretary of Defense for Acquisition and Logistics in his 1985 report, an independent service that would report directly to the Secretary of Defense.

What are the implications of such a major restructuring of the acquisition system? The concept of an Acquisition Service, independent of the military services (Army, Navy & Air Force), is somewhat revolutionary. The concept of eliminating the military from within this service is even more so.

What unique qualities do the military bring to the procurement process? Critics of the concept of eliminating the military from the acquisition business most often point out that the military, being the eventual users of any weapons that are procured, are best able to provide insight as to the concerns of the fighting men. This argument loses much credibility when subjected to the light of reason. If an officer, at the Program Manager level, actually has experience in the use of a weapon

system, it is most likely that the weapon system is obsolete. The fact that a General served on a Minuteman Missile crew twenty years ago does not provide him with additional credibility when discussing the unique features of a Peacekeeper or Small ICBM weapon system.

Weapon system technology is advancing at a more rapid pace today than ever before, and will only accelerate in the future. This means that problems that were experienced in the past may have no relevance to future systems. In any event, if operational experience is determined to be an essential element of a competent acquisition specialist, then former military officers with weapon system experience could be hired after completion of their tour of duty, or acquisition service individuals could be permitted to accomplish a tour of active military duty with a particular weapon system. The complicated requirements associated with the acquisition system dictates that individuals must be trained in a broad spectrum of disciplines, from entry into the military, through the latter stages of the officers career.

The Packard Commission recognized the criticality of this requirement, and recommended that military officers proceed along a "well defined acquisition career program"[7] toward improving the qualifications and training of Program Managers. The Air Force has initiated a development training program for acquisition professionals that includes career development assignments, training and education with the ultimate goal of professionalizing the Acquisition workforce.

This program (The Acquisition Professional Development Program or APDP) combines the "three pillars" of Experience, Training and Academics to guide managers through successive levels of development. While this is indeed a commendable goal, it has little bearing upon the fundamental question as to the need for the military in the acquisition business. If it is sensible to develop a future executive through a structured, long-term program (and few would argue with this position), then perhaps the process would best be served by eliminating the military requirement in its entirety.

This premise is based primarily upon two main considerations. The first is that the most productive period for a business executive is the period between his 40's to 60's. It is during this period that he realizes the results of his formative period. The military services traditionally lose a good many of their more successful officers during this period. Only a relatively small percentage of individuals receive promotion past the rank of Lieutenant Colonel.

While it is true that those individuals who remain are truly outstanding, it is a great waste of potential to lose those who are not promoted to the rank of Colonel. The rest of the highly productive, successful acquisition experts are allowed, even encouraged, to leave the military. The fact that such a large percentage of these individuals go to work for defense contractors, in senior level positions, merely underscores the fact that valuable resources are being wasted under the current system.

It may be perfectly reasonable to have a retirement program in effect that encourages individuals in their forties to retire from military service. It is not reasonable to have acquisition specialists retiring at such a relatively early age. For a "warrior" the forties represents the beginning of the decline of physical abilities. It is ludicrous, however, to lose an individual whose

primary responsibility is that of business management (i.e. an intellectual career) at that relatively early stage in his career.

The military relinquishes the benefits of the experience and ability of highly skilled, dedicated individuals who have only recently reached the zenith of their productive capability. It is perhaps useful to compare the career tracks of the professional military acquisition executive with that of executives within the private aerospace community. During the age at which military executives are "retired" from government service, aerospace executives are still in the developmental stages of their careers. The most productive period for executives in industry is the 45-60 year age group. It seems inconsistent at best, and highly wasteful at worst, to allow the military system to drive out some of the most respected members of their profession who still have many productive years remaining. The proof of this productivity is the willingness of private aerospace contractors to offer them important positions within their industry.

The second consideration relates to the military's "up or out" system. Military members are often promoted out of a position in which they are most productive and required to accept a position in a management capacity. While this may be reasonable when dealing with those individuals in the fighting branches (and some would argue that it is not a reasonable approach even there), it is most unfortunate that such a policy would exist in the acquisition field. There are any number of individuals who would only ask that they be allowed to remain in their current position. The research engineer and the theoretical scientist who happen to be officers in the military are required to move "up the ladder" to administrative and management positions if they are to remain in the military (with only several exceptions). This places the individual in the onerous position of having to choose between a career and a job. As the military officer advances in grade, from company grade to field grade, his/her responsibilities become more management oriented.

This type of choice would not be required in an Acquisition Service. Some would argue that the individual has the option of working for the civil service. Unfortunately, this option has severe limitations as well. The key point is that a significant loss of productivity is tied to the individual's association with the military system and the responsibilities associated therein, rather than to the acquisition system.

Having articulated the two major criticisms of the military system, I would be remiss if I do not articulate some of the benefits associated with having military individuals involved in the acquisition process. The first benefit, would be the broad-based, highly motivated, professional individuals who enlist in the military to serve their country. Would the commensurate level of quality individuals be available to an acquisition service? Could an acquisition service attract and retain individuals who are as talented and dedicated as those who currently hold down these assignments? Could we expect the blue-suiters to trade them in for business suits or would the government lose these individuals to the private sector?

In the course of discussing the premise that we need to get the military out of the acquisition business, there is significant concern on the part of some in the military that civil service employees

are neither as dedicated, nor as talented as their contemporaries in uniformed service. They do not believe that civilians would be as motivated, nor as willing to make sacrifices, i.e. mobility, that are required to ensure that the acquisition system operates effectively.

I believe that there are many flaws in the way that the civil service personnel system is currently structured. An Acquisition Service, with a system of rewards and benefits similar to those of the military, would attract more qualified individuals than does the current system. This contention is based upon several basic assumptions, the first would be that there would be a revision to the personnel system to allow comparable professions for acquisition service employees. This would allow the services to compete for the better educated, more highly motivated individuals who, it has been argued, currently come from the military members of the acquisition workforce. In this context, an Assistant Secretary of Defense for Acquisition and Logistics has proposed that:

> "a fresh approach is necessary to assure that the DoD is able to maintain a first rate professional acquisition and logistics workforce. We lack a cadre of seasoned, well-rounded, technically oriented acquisition professionals. These people are the key to improving the DoD systems acquisition process. While no amount of reorganization will, by itself, solve these problems, a system which results in clearly defined lines of authority, responsibility, and accountability and manned by experienced, high tech oriented, professionals dedicated to making the system work has a far better chance of success... A true service Corps with dedicated professionals is a necessity. Management of the Corps, in the main must be by civilians rather than military personnel who rotate out after a number of years. Experience and ability must be the key determinants for advancement, as well as more discipline in carrying out the objectives of the Office of the Secretary of Defense...We do not need more people--but we do need superior, better qualified people. To attract these people we need changes in pay structures, rotational programs, training and more flexible personnel procedures."[8]

While it is true that this theme (the need for a more professional workforce) has been a consistent one throughout the many commissions on procurement reform, i.e. Grace Commission, Hoover Commissions etc., it is nonetheless true that given the new realities of a sizeable force reduction, a consensus is developing toward the need for a revitalization of this workforce. It must be made quite clear that the elimination of the military from the acquisition workforce must be accomplished in conjunction with the overhaul of the acquisition personnel system or the result would most likely be the exchange of one set of problems for

those of another.

The Packard Commission and the Defense Management Review both recognized the need for significant personnel restructuring in their reports to the President.

> "One extremely important means to improve the acquisition workforce is to establish an alternative personnel management system permitting greater flexibility with respect to the status, pay and qualifications of civilian employees."[9]

An experimental personnel system that was evaluated was the China Lake project. Results from that project indicated that there was an increase in productivity along with a higher degree of job satisfaction. The positive feedback from this program demonstrates that there truly is a dedicated corps of acquisition specialists who would like to see the personnel system overhauled to reward productivity and eliminate the deadwood. We need to overhaul the civil service personnel system through use of the stick and the carrot. The stick to eliminate the nonproducers, and the carrot to reward the over-achievers. Supervisors and managers are continually frustrated by the lack of effective remedies against non-productive employees. The impact of these individuals upon the morale of the organization cannot be overstated. It is unfortunately all too true that incompetent and lazy individuals are often relegated to menial duties while still receiving the benefits of seniority and pay increases that are due to the more competent coworkers. In some cases individuals have even been promoted in order to get them out of a particular position, where they have demonstrated an incompetence.

If there is to be a stick, then it is also appropriate that there be a carrot. Rather than reward an employee for time in grade, i.e. solely on seniority, it would be more productive to reward him for the degree of success that he/she may have in their position in conjunction with the degree of difficulty of that position. Thus, an engineer on a particularly complicated weapon system would receive a higher pay than one on a less complex one, even if they do comparable work.

It has been argued that the government can not compete with the private sector for the limited number of skilled individuals in the weapons acquisition field. While there may be an element of validity in this position, the services have traditionally awarded contracts to the private sector for engineering services (for example the Air Force has contracts with TRW for Systems Engineering). There is no reason to believe that these individuals would not work for an Acquisition Service if it were able to offer comparable wages and benefits. If this were to be a problem, many of the program engineering requirements could be contracted out to systems engineering firms such as TRW. It is most likely, however, that given the large reductions associated with the DoD downsizing, there will be a highly qualified and motivated workforce available to draw from.

If the military is to be eliminated from the acquisition process, then it would seem prudent for the new Acquisition Service to incorporate some of the military's more forward thinking programs. The ROTC and OTS programs provide the military with future leaders. They are extremely valuable means of ensuring a continuous supply of leadership for the services. ROTC utilizes the

resources of college universities to supply future leaders with both an education and an opportunity to experience the military environment prior to commissioning. The Acquisition Corps should consider a training program at the college level which would provide a similar opportunity for future acquisition leaders. In exchange for joining the acquisition service, and incurring a four year commitment, college students in appropriate curricula would be offered scholarships and training in the acquisition profession. This would include specific acquisition training as well as a summer camp at a program office or acquisition headquarters. There are many possibilities for this type of program; however, the basic premise would be that executive intern candidates from this program would have an acquisition experience rather than a military one. Similar programs at advanced management levels could be implemented with associated commitment to government service.

While the two major reasons for the elimination of the military have been discussed, there are additional problems that are associated with having the military in the acquisition business. One of these is the conflicting demand upon the military officer for his training and education. Military officers are highly encouraged to have Professional Military Education (PME) completed at specific points in their careers. This education (for the Air Force) consists of basic PME (Professional Military Education e.g. Squadron Officers School), intermediate level PME (a service staff college e.g., Air Command and Staff) and a senior level PME (a service war college or equivalent, e.g., Air War College or the Industrial College of the Armed Forces (ICAF). Additional PME includes Armed Forces Staff College, and the Naval Postgraduate School.

While these courses offer much that is useful to an officer in the acquisition career field, it is a fact that the curriculum is tailored for military officers, and as such contains much information that is essentially irrelevant to the majority of officers in the acquisition business. The related material could be addressed in educational training that would be accomplished in conjunction with acquisition related course work (i.e. at the Defense Systems Management College).

Another problem that is associated with the military is that of rank sensitivity. The military, being essentially an authoritarian society with the hierarchy clearly defined by the rank on an individual's sleeve or shoulder, is not often receptive to dissenting opinions. The head of an independent acquisition service would be more likely to respond to the produceability and need for a specific weapon system without the pressures that are inherent to a military officer under the military chain of command.

This is not to say that all political leverage would be eliminated from the acquisition process. The reality of the situation is that there are political forces and pressures on those influential in the acquisition decision making structure. Given the enormous sums that are required to develop and field a major weapon system this is inevitable. By eliminating the military from the acquisition system, one set of political priorities will be eliminated. The competition between the Military Services will not go away with the creation of an Acquisition Corps. It should however provide a less biased opinion regarding the capabilities of specific weapons. The decision as to how resources are to be allocated will not change materially. The viability of that system is not the

subject of this paper. The independent nature of a non-military acquisition corps in theory would help to override some of the inter-service rivalries that have been known to create redundant systems due to one service's unwillingness to buy another's system.

Another concern regarding the use of military in the current system relates to the lack of cohesive policy between the services regarding the roles and responsibilities of the military personnel within the acquisition process. Each service has its own unique style regarding the method that they buy weapons. This often creates difficulties for defense contractors who have experience with one branch, when they wish to compete for programs offered by another service.

The Air Force has military officers assigned as Program Managers of System Program Offices with project engineers (usually Lieutenants or Captains) assigned to subsystem responsibility. Several layers of management coordinate the total program acquisition, with a senior officer (usually a one or two star General Officer) acting as Program Executive Officer. Acting as Systems Engineering support may be a private contractor (such as TRW). The army uses civilians as the heads of their directorates and also utilizes civilian engineers in a project engineer capacity. The Navy normally has a small program office staff of military and civilians but contracts out to the private sector for a systems integrator who will accomplish much of the development that the other services do themselves. The different approaches to weapon system acquisition has created uncertainties when contractors are required to participate in different service's programs.

Consistency of approach toward weapon system acquisition would go a significant way toward improving contractor/government relations. This would be possible through a central civilian acquisition service because while the terminology of position descriptions may vary from Service to Service the essential position characteristics remain very much the same.

Interestingly, the promotion system of the military is seen to be both a positive and a negative consideration. While the system is capable of weeding out the incompetent, and does provide a greater degree of flexibility for supervisors, promotions are based on evaluation reports by supervisors, which have required overhaul every few years due to OPR inflation. The competitive nature of the rating system serves to motivate some individuals, however it also tends to discourage initiative and leads to a mind-set of following the path of least resistance. It also tends to discourage risk taking and initiative, two valuable commodities in the new period of change.

The rotational nature of the military also provokes opposing viewpoints. One view holds that the military, by the nature of their mobility, are better able to bring a comprehensive perspective to the acquisition process. The opposing view states that the military become jack-of-all-trades and master of none. Rotational assignments often result in the loss of corporate memory and create program instability.

There is an inherent instability associated with having a Program Manager evaluated on the basis of short-term results. The incentive is to forsake long-term creative solutions that have more up-front costs because programs are most vulnerable to cancellation during the early stages of development. Evaluations are based upon the present and

most recent past. Thus, a manager who comes in to solve a problem is given better marks than one who avoids the problem in the first place through good management.

The DMR recognized this system weakness and recommended that Program Managers be evaluated upon the long term success or failure of a weapon system. To provide effective evaluation of an acquisition manager, there should be more of the cradle-to-grave approach. If he is given the responsibility for correcting future problems, the program manager would be more receptive to short-term losses if they would result in long-term gains. The corollary that incentives must be provided to motivate quality individuals toward a career in DoD acquisition is obvious. A related concern would be the necessity to reward program managers even if they are the bearers of bad tidings, i.e. if programs overrun or prove impractical, early recognition should be rewarded, not punished.

Given the visibility of the revolving door situation, does it make sense to expect individuals to work for the government at reduced salaries with no expectation of eventually going to work for the private sector? The Services and the DoD are aware of the increased support within the Congress for a change in the way weapon systems are acquired. The DMR represented (at least in part) a recognition that the system was in need of a change.

Unfortunately, the DMR doesn't go far enough in restructuring the weapon system process. The Program Executive Officer concept has created an additional set of problems and concerns. Rather than simplifying the organizational structure, it has resulted in a convoluted system that often seems to incorporate the worst of both worlds. The intent was streamlining, the result was a somewhat disorganized system that creates uncertainty at the working level (i.e. Program Office) with regard to chain of command and program responsibility.

CONCLUSION

The Defense Acquisition Workforce Improvement Act attempts to reconcile some of these problems however, it is a band-aid approach. The band-aid approach will not resolve the need for major structural changes in the Clinton Administration's DoD. The elimination of the military will not resolve all of the defects in the system. It will, I believe, in conjunction with the other recommendations identified herein, serve to improve the system and eliminate some of the problems associated therein. the conclusions of this paper are as follows:

1. Remove the military from the acquisition business. Offer those members of the uniformed services currently on active duty the option of transitioning into an acquisition service or accepting alternative career positions within the military. Equity would dictate that those who choose to remain in the Acquisition Service be given credit toward retirement for their time in the military. Perhaps a graduated plan that would allow those individuals with significant time to retire closer to the current 20 year system.

2. Transition those individuals within the civil service into the acquisition service. There would be a separate set of personnel regulations, perhaps similar to the excepted service. There would also be a new pay and incentives structure. Reference the China Lake project for recommendations along this vein. Additional training would be mandatory for those lacking the minimum mandatory acquisition courses.

3. Initiate those actions required to implement an Acquisition Executive Intern Training Program at selected Universities to develop future Acquisition Executives.

4. Standardize an executive development training program for use in the Acquisition service, adopting the best of each of the services current programs.

5. Consider the possibility of consolidating many of the Systems Engineering contractor functions into the acquisition Service. This would necessitate a pay scale commensurate with the Contractors who provide these services (i.e. TRW, Aerospace), however, given the current employment outlook, it would not seem unreasonable to bring the required expertise on board at a rather large reduction in cost to the DoD.

The bottom line is to remove the military from the process in all capacities except that for which they are most ideally suited, and that is as the user of the final product. This will only prove effective in an independent Acquisition Service. It will also only be effective if the changes to the civil service are accomplished in conjunction with the creation of the Acquisition Service.

It is vitally important to recognize that this recommendation in no way reflects upon the fine job that the military provide to the current acquisition system. These changes will not ameliorate any of the other major concerns that relate to the way the DoD conducts its acquisition business. Budget turbulence, PPBS inadequacies, Congressional micromanagement will not go away by removing the military from the process. I do believe that my recommendations can bring an element of stability to the current environment that is now lacking. Further, I believe that this recommendation will result in sizeable savings to the cost of procuring weapon systems.

The implementation of the concept of Total Quality Management and the search for continuous process improvement, dictates a revolutionary change along the lines indicated above. I believe that the acquisition professionals that are currently a part of the weapons acquisition process, would benefit from these changes as would the men for whom the weapons are intended - the American soldier.

Authors

James H. Gill, Primary Author, GM-13, USAF
Robert J. Bemben, GM-13, USAF

1. Putting People First, How We Can All Change America, Bill Clinton, Al Gore, Times Books, p.80

2. ibid, p.133.

3. Ibid, p133.

4. AFMC Policy white paper, 28 Jan 1992, General Yates and McDonald, Introduction, p.2.

5. Total Quality Leadership Program, Space Systems Division, p.8.

6. Defense News, Nov 23-29 1992, p. 10.

7.. "A Quest for Excellence" the Final Report to the President by the President's Blue Ribbon Commission on Defense Management", pg 67.

8.. DoD Acquisition Improvement - The Challenges Ahead, Perspectives of the Assistant Secretary of Defense for Acquisition and Logistics, November 5, 1985, pg. 6.

9.. A Quest for Excellence, the Final Report to the President by the President's Blue Ribbon Commission on Defense Management, June 1986, pg.67-68.

ACTIVITY-BASED COSTING: IS IT VIABLE FOR DEFENSE ACQUISITIONS IN THE 90's?

Major Steve G. Green and Cadet Troy R. Harting
United States Air Force Academy
and
Mr. Donald P. Gudzune
Martin Marietta Corporation

ABSTRACT

Organizations that survive the 90s will be those that can adapt. And one key to a modern organization's adaptive capacity is an accounting system that provides relevant and reliable information.

Decision makers have been placed in a precarious position as pressure mounts to modernize accounting systems commensurate with the technology available, while simultaneously, a justified fear prevents managers from experimenting with accounting methods or procedures that may place their cherished and hard-earned accounting credibility in jeopardy.

With this challenging business environment stage set, this paper will describe and explore specific issues and concerns associated with implementing innovative cost management approaches from both the government's and defense contractor's perspective. A recommended potential course of action will attempt to guide decision-makers through the realities of doing business in the defense world in the 90s.

From the government's perspective, how could anything that has so many people thinking of ways to improve reporting and accountability be bad? But there are a host of important issues that must be addressed. First and foremost, considering other accounting practices and procedures, ABC is relatively immature. Second, any change of this type would surely require a lengthy transition period. Third, ABC implementation is expensive. Fourth, how are ongoing projects to be handled? Finally, there is a litany of regulations, laws and conventions that need to be addressed.

From the contractor's perspective, there are many issues to consider. First, it is not a wise investment at this time. Second, most implementation issues are unresolved. Third, who really wants ABC? Finally, there are other complications that need to be addressed: loss of cost estimating capabilities, potential problems with forward pricing rates, cost proposals, negotiations, cost performance data, and potential "No-Fee" or "disallowable" labels on "non-value added activities." Finally, there is no penalty for not adopting ABC.

We feel if several conditions exist, ABC implementation will be feasible for our defense industry including: ABC must be validated and accepted in other fields, our anachronistic CAS system must be modernized and the current turbulence and uncertainty in our defense industry must stabilize.

With these conditions met, several steps could be taken to enhance successful ABC implementation. First, ABC must be encouraged/supported by customers and suppliers alike. Second, all government agencies must be fully aware of all ABC activities. Second, keep it simple. Third, select a pilot program and finally, be extremely sensitive to labelling non-value added work.

Clearly there is a strong argument that in our current acquisition environment, some if not all of these conditions and steps could not realistically be accomplished. For that reason we feel that implementing ABC to improve cost information might be exactly the right thing to do, but now might be exactly the wrong time to do it.

ACTIVITY-BASED COSTING: IS IT VIABLE FOR DEFENSE ACQUISITIONS IN THE 90's?

Major Steve G. Green and Cadet Troy R. Harting
United States Air Force Academy
and
Mr. Donald P. Gudzune
Martin Marietta Corporation

Organizations that survive the 90s will be those that can adapt. And one key to a modern organization's adaptive capacity is an accounting system that provides relevant and reliable information. In response to this need, the accounting community has developed what is popularly referred to as cost management.

While many authors depict cost management as a discipline that is finally coming of age, others suggest that it is actually only in its infancy. Examples supporting both of these positions are vividly illustrated when examining the *history of cost management* for corporations that deal primarily with the Department of Defense (DoD). In many respects, our defense industry is the most sophisticated and innovative sector in the world. In other respects, specifically dealing with pioneering accounting practices and procedures, the defense industry is bogged down by laws, regulations and other realities of today's marketplace.

Attaining the desired level of cost management efficiency and effectiveness is a difficult and costly proposition for many reasons. The unprecedented capabilities ushered in by the "Information Age", coupled with the current dynamic world situation and a larger than anticipated reduction in the need for new major weapon systems, have created a classic "Catch-22" for defense firms. Decision makers have been placed in a precarious position as pressure mounts to modernize accounting systems commensurate with the technology available, while simultaneously, a justified fear prevents managers from experimenting with accounting methods or procedures that may place their cherished and hard-earned accounting credibility in jeopardy.

All of this is happening at a time when investment capital for improvement efforts of the dimensions required is basically nonexistent. To make matters worse, the outlook for future business appears be out-pacing analysts' worst case predictions. There seems to be no reward for risk-taking, but negative incentive for inaction.

This dilemma is further complicated as other state-of-the-art management initiatives are embraced and discarded in succession. Today's decision-makers find themselves having to exercise extreme caution when advocating improvement efforts as they may see their favorite "management fad" vanish - along with their personal credibility.

A final complication is the mountain of laws and regulations imposed upon defense contractors by the government. While these actions were taken mainly in response to a public outcry for increased accountability of government spending, the end result is a heavily regulated business environment that is generally change adverse.

With this challenging business environment stage set, this paper will describe and explore specific issues and concerns associated with implementing innovative cost management approaches from both the government's and defense contractor's perspective. A recommended potential course of action will attempt to guide decision-makers through the realities

of doing business in the defense world in the 90s.

ACTIVITY-BASED COSTING

A sampling of the popular business press and professional accounting literature would lead one to believe the accounting community has firmly embraced the fact that revolutionary change is in motion, and the transportation mode of choice is Activity-Based Costing (ABC); further, the ABC train has left the station and continues to pick up passengers at each stop. ABC (also referred to in a broader concept as activity-based management) has as a primary purpose, to provide information for decision makers' internal use. ABC also permits the decision maker to concentrate on the management of resources instead of external or internal requirements.

While this is exactly what traditional cost and management accounting provided in the past, they seem to have experienced a savage barrage of criticisms from academics and practitioners alike. Conventional cost system bashing is easy, fun and makes you look smart! Also, advocating traditional "absorption" type cost systems grows increasingly difficult when such systems consistently fail to provide relevant and timely information, especially in an era of scarce resources associated with the modern workplace.

More specifically, ABC is a method of measuring cost and activity performance associated with production or services. The idea behind ABC is that products or services require activities and activities consume resources. A manager will essentially assign costs to cost objectives based on their use of a specific activity. The most obvious benefit is that instead of merely information on how costs are consumed, the work being performed is highlighted.

ABC and the apparent simultaneous emergence of Total Quality Management (TQM) on the contemporary business scene in the mid-1980s gave managers a staggering one-two punch just as their backs were figuratively against the ropes.

TQM, with an associated philosophy of customer satisfaction and a focus on process improvement, highlighted that activities can be managed, unlike costs that are basically collected and reported after the fact. By eliminating non-value added activities (work) associated with the processes (primary functions) of the organization, costs could not only be accounted for, collected and reported in a more timely manner, they would prove to be more representative of what actually occurred on the production line or at the service window. Even more appealing was the fact that these activities could be systematically and judiciously "reduced" by managing the activities that actually consume the resources as opposed to the traditional orientation of products absorbing costs. This entire management process can be oriented toward continuous improvement and before long, TQM is virtually in perfect harmony with ABC efforts.

There are many that would probably argue that ABC evolved out of a need to accurately address the seemingly out-of-control and ever-inceasing overhead (or common cost) accounts. Although not the sole culprit, automation has decreased the labor content of certain functions and significantly increased the general overhead levels across the board. This phenomenon made ABC, with its focus on allocation of overhead particularly attractive. Instead of allocating all of this overhead by some volume related metric (direct labor hours etc), overhead is decomposed and allocated by more appropriate "cost drivers." Traditional cost elements (direct labor/material) would still be used when appropriate, but now would be accumulated by activity and allocated by appropriate cost driver.

The end result of improvements to costing, such as ABC, is a potential

increase to the bottom-line (profits). This alone might be what caused eyebrows to rise in corporate boardrooms across the country as controllers began advocating ABC implementation. But what about the public sector? Can the government, and specifically the DoD reap the same benefits that ABC seems to be providing the private sector?

ABC IMPLEMENTATION ISSUES FROM THE GOVERNMENT'S PERSPECTIVE

From the government's perspective, how could anything that has so many people thinking of ways to improve reporting and accountability be bad? Implementing ABC is of such interest to everyone because it directly affects such fundamental activities as contract payment, future contract negotiation, cost performance and cost estimating and analysis. Further, all of these have potential impact on the bottom line - profit.

Simply put, profits are a function of cost. And profits are where DoD agencies exercise the lion's share of their negotiations. Consequently, both parties have ample incentive to possess accurate, timely and relevant cost data and then reduce those costs once identified. The recent emphasis by many authors on cost management extends beyond cost control or cost accounting to touch at the complex relationships between cost and price. This could be the primary reason ABC has received so much positive press. It creates a virtual line-of-sight view of how the mix of an organization's diverse activities and processes contribute to the bottom line, and provides a credible audit-trail as well. This is particularly tantalizing to decision-makers who have already accepted (in principle) or have already invested time and/or money into improvement efforts such as TQM.

With all of ABC's attributes, it is hard to understand why the government might balk at this apparent "win-win" situation. But there are a host of important issues that must be addressed.

First and foremost, considering other accounting practices and procedures, ABC is relatively immature. The DoD cannot afford to experiment on a large scale with a basically "unproven" concept.

Second, any change of the magnitude associated with implementing a new cost system, would surely require a lengthy transition period. During this time span, there might be a requirement for "two sets of books", if not more. Accountability becomes difficult and credibility will always be on the line.

Third, ABC implementation is expensive. From early feasibility studies, to the actual software, to the huge investment of manpower, ABC is an expensive proposition. It is also critical to note that there would be a huge opportunity cost of a firm's top financial staff working on the ABC transition.

Fourth, how are ongoing projects to be handled? This is especially pertinent to the large, multi-year efforts that are often the lifeblood of many defense contractors. Do we change the accountability and performance measurement rules of the game halfway through the life of a program, or are some programs grandfathered?

Finally, there is a litany of regulations, laws and conventions that need to be addressed and resolved before ABC can successfully be implemented. Of most urgency are government mandated Cost Accounting Standards (CAS), and the potential flagrant violations ABC could effect. The key to successfully dealing with CAS is to have a cost system that records contract costs and provides relevant and useful information. Even though the use of ABC to assign corporate costs to divisions or business units particularly suits defense contractors, implementing ABC systems would require a comprehensive look at the twenty cost standards issued by

the Cost Accounting Standard Board (CASB).

Of particular note would be CAS 402, "Consistency in Allocating Cost Incurred for the Same Purpose", and CAS 406, "Cost Accounting Period." All organizations concerned would have to demonstrate great flexibility as the unique nature of each organization and of each cost are addressed. Finally, CAS 410/418/403, generally "the Allocation of Indirect Costs", would be, to borrow a phrase, "the difference that makes a difference." Even though this area would experience transition pains, this is where ABC will either shine or disappear. But in general, the use of a "causal/beneficial base" is preferred to the use of a general or residual base that cannot be charged directly. ABC, with its cost driver orientation, appears to satisfy CAS. However, ABC implementation would probably require monumental change/flexibility by the CASB.

In our current era of shrinking defense budgets, ABC systems that are reliable, efficient and accurate would prove to be of immeasurable value to all parties concerned. The DoD, it would seem, has much to gain through the adoption of ABC. The question remains as to whether the benefits outweigh the costs.

ABC IMPLEMENTATION ISSUES FROM THE CONTRACTOR'S PERSPECTIVE

The bottom line is: if ABC is such a great idea, why are aerospace contractors not knocking themselves out trying to be the first to fully implement it? Are they so rooted in antique accounting practices and procedures that they fail to recognize the benefits of ABC? Maybe, there is another side to the ABC story.

Assume that you are the CEO of a moderate size aerospace firm of 5,000 to 7,000 employees with sales of one billion dollars last year, (of which 90% were DoD agencies). You have recently presided over down-sizing 10-15% of your employees, sales forecasts are falling through the floor, burden rates are rising exponentially and your work force is partially paralyzed by "layoff anxiety."

Not a pretty picture, but you are convinced that with judicious financial constraint, product area consolidation, and aggressive bidding for the limited opportunities that do exist, your firm can ride out this cycle. But for now, the shriveling DoD budget calls for prudence and budgetary vigilance on all fronts.

It is in this environment that your controller convenes a high level review to present to you his recommendation to pursue something called ABC. The pitch crisply describes the theoretical power of ABC to better define costs, illuminate the vague world of indirect costs, and highlight non-value added activities. It is also quite evident that your controller, as an *accounting and financial professional*, is enthusiastic about the concept of implementing ABC in your company. Although you clearly see the value of ABC, as CEO you have to look at each business decision from an investment perspective; specifically, what is the projected Return on Investment (ROI) of ABC, and simultaneously what is the penalty or cost of *not* implementing ABC at this time?

After the presentation and extensive dialogue, you draw some conclusions regarding ABC. First, it is not a wise investment at this time. Implementing ABC involves tying up some of your top people for 3-5 years researching cost drivers and setting up various cost pools. Total implementation cost estimates range from \$15-\$40 million precious overhead dollars and the benefits, though attractive, are still very much theoretical. From an ROI perspective in uncertain times, it just does not add up.

Second, the implementation issues are formidable and unresolved. Transition to ABC requires a new government

disclosure statement, cost impacts, massive education/training programs, new estimating methodologies, and an increase in administrative cost to manage a significantly more complex accounting information system. Additionally, no one has yet figured out how to "cut over" to ABC. Do you grandfather existing programs under the old accounting structure (so as not to upset your current customers with cost impacts and new accounting complications) while applying ABC to new programs? But treating the same costs differently on separate contracts is a violation of CAS. Or do you switch all programs to ABC as of some date and incur the possible wrath of valued customers who, prior to implementation of ABC, felt comfortable with cost behavior on their programs and had an Estimate at Completion (EAC) they could track? Unless you are starting out with ABC in a new facility with new contracts, the transition would appear to be a lose-lose proposition.

Third, who wants ABC *anyway?* ABC is highly desirable for its apparent ability to provide sorely needed insight into cost and profit drivers. But when was the last time your customer asked you how your company was doing with ABC implementation? The fact is that not only are contractors feeling *zero* pressure to migrate out of current accounting systems to ABC, a formidable implementation task would be the education/training (selling) of customers and customer representatives of the merits of ABC.

Fourth, there are a few "Honorable Mention" complications, including:

A) Loss of cost estimating (heuristic and parametric) relationships developed over many years.

B) Potential increase (by a magnitude) of complexity of forward pricing rate packages, cost proposals, negotiations, and cost performance data/reports.

C) Potential government imposition of "No-Fee" or "disallowable cost" on "non-value added activities" or on "idle capacities."

Finally, there is no immediate, significant penalty of not adopting ABC. In short, without significant help and regulatory relaxation from agencies trained and incentivized to do just the opposite, it would appear that you can't get there from here.

No external forces, government or competitors, are driving the expenditure of huge amounts of scarce capital. And considering that contractor accounting systems are working well, it would seem prudent to ride out the storm.

WHAT DOES THIS MEAN FOR ABC AND SYSTEM ACQUISITIONS?

All parties involved with major weapon systems acquisitions seem to agree that ABC has merit. The DoD and the contractors who have stepped up to ABC appear to concur on the fundamental benefits of an innovative accounting system that might clear the fog surrounding overhead expenses and thus produce more meaningful and accurate estimates of product costs. The rub is associated with implementation; despite the benefits, the realities of corporate operations in the defense enclave demand that a host of issues be resolved, or at least addressed in open forum at the highest levels, before ABC doctrine and practices can be realistically embraced. We feel if several conditions exist, ABC implementation will be feasible for our defense industry:

1) ABC must be validated and accepted in other fields, disciplines and industries. Its theoretical tenets must be proven more substantially in order to gain better acceptance. Unfortunately, we recognize that this is usually a function of time; yet another of our scarce resources.

2) Certainly our anachronistic CAS system must be modernized in order to deal with the advent of ABC. Current standards discourage realistic implementation, and further, justifiably fail to encourage innovation and improvement.

3) The current turbulence and uncertainty in our defense industry must stabilize. At present, the resources do not seem to exist to attempt ABC implementation, and investment horizons are short.

With these conditions met, several steps could be taken to enhance successful ABC implementation:

1) ABC must be encouraged/supported by customers and suppliers alike. ABC education is a neccesity, and upper management champions must be developed. Tough job, especially as other management initiatives have gobbled up all of the bosses' attention. Also, it is imperative that all government oversight agencies (DCAS, DCAA, etc.) be fully aware of all ABC implementation activities.

2) Keep it simple. Do not try to "reinvent the wheel." Research other defense firm's efforts as you would benchmark quality efforts. Pick one product area with a clean cross-functional support structure. This will facilitate recognizable cost driver identification.

3) Select a small autonomous site for a pilot program. Emphasize product "families" and try to achieve an early success while addressing all required disclosure implications.

4) Be extremely sensitive to labelling value/non-value added work. More than just feelings might be damaged as processes and primary activities are defined.

While meeting these conditions and steps is not a recipe for guaranteed success, they will help organizations address ABC implementation. Clearly there is a strong argument that in our current acquisition environment, some if not all of these conditions and steps could not realistically be accomplished. For that reason we feel that implementing ABC to improve cost information might be exactly the right thing to do, but now might be exactly the wrong time to do it.

This project was funded in part by the Defense Systems Management College, Ft Belvoir, VA.

Major Green is a Tenure Associate Professor of Management at the United States Air Force Academy. He has over 8 years of acquisition experience in major weapon systems program offices. He holds a DBA from United States International University, a MS from University of Southern California and a BS from the United States Air Force Academy. He is also a CCE/A.

Mr Gudzune has over 16 years of acquisition experience including 3 years with the DoD and 13 years at various management level financial management position with Martin Marietta Corporation. He holds a MBA from Denver University and a BS from the University of Delaware. He is also a CCE/A.

Cadet Harting is a senior Management Major at the United States Air Force Academy. Upon graduation he plans on an acquisition career in the Air Force.

Bibliography

Brinker, Barry J., ed. Handbook of Cost Management. Warren, Gorham and Lamont: Boston, 1992.

Cooper, Robin and Robert S. Kaplan. "Activity-Based Systems: Measuring the Costs of Resource Usage." Accounting Horizons September, 1992.

Cooper, Robin and Robert S. Kaplan. The Design of Cost Management Systems. Prentice Hall: Englewood Cliffs, 1991.

Cooper, Robin. "How Cost Accounting Distorts Product Costs." Management Accounting, April 1988.

Cooper, Robin and Kaplan, Robert S. "Measure Costs Right: Make the Right Decisions." Harvard Business Review, September - October, 1988.

Cooper, Robin. "You Need A New Cost System When..." Harvard Business Review, January - February 1989.

Government Accounting Office. Cost Accounting Issues: Survey of Cost Accounting Practices at Selected Agencies. GAO/AFMD 90-17, February 1990.

Harr, David J. "Activity-Based Costing: New Insights For Cost Management." Armed Forces Comptroller, Spring 1991.

Haedicke, Jack and David Feil. "Hughes Aircraft Sets the Standard For ABC." Management Accounting, February 1991.

Johnson, H. Thomas. "Activity-Based Information: Accounting for Competitive Excellence." Target, Spring 1989.

Johnson, H. Thomas. "It's Time To Stop Overselling Activity Based Concepts." Management Accounting, February 1991.

Johnson, H. Thomas and R. S. Kaplan. Relevance Lost: The Rise and Fall of Management Accounting. Harvard: Boston, 1991.

Johnson, H. Thomas. Relevance Regained. Free Press: New York, 1992.

Kaplan, Robert S. "The Evolution of Management Accounting." The Accounting Review, July 1984.

Kaplan, Robert S. "One Cost System Isn't Enough." Harvard Business Review. January - February, 1988.

Pipken, Al. "The 21st Century Controller." Management Accounting. February 1989.

Rezaee, Zabihollah. "Designing Cost Accounting Systems For Government Contractors." Armed Forces Comptroller, Winter 1989.

Roehn, Critchfield, and Castellano. "Yes, ABC Works With Purchasing, Too." Journal of Accountancy, November 1992.

Steimer, Thomas E. "Activity-Based Accounting For Total Quality." Management Accounting, October 1990.

Turney, Peter B. B. Common Cents: The ABC Performance Break-Through. Cost Technology: Hillsboro, 1991.

Turney, Peter B. B. "Ten Myths About Implementing An Activity-Based Cost System." Journal of Cost Management, Spring 1990.

IMPLEMENTATION OF THE INTEGRATED MANAGEMENT SYSTEM IN THE CENTRAL TACTICAL PROCESSING PROGRAM (CTPP)

An Experimental Request for Proposal

Beryl A. Harman, Defense Systems Management College

ABSTRACT

The Central Tactical Processing Program CTPP is a $25 million, one of a kind, experimental ground station in support of the Defense Support Program (DSP), funded with research and development funds under the Defense Strategic Initiatives Program (SDI) This critical experiment received authority to proceed on 6 Mar 92, and was awarded through formal source selection procedures under Air Force Regulation 70-30, without discussions, on 3 Aug 92. Since this program was on an accelerated schedule, it was decided to utilize acquisition streamlining techniques and to include the Integrated Management System (IMS) concept developed for the F-22 aircraft at the Aeronautical Systems Center at Wright Patterson Air Force Base. In addition it was decided to utilize an Integrated Product Team (IPT) to implement the acquisition process. This paper describes the process that was implemented; the innovations that were used in both the Request For Proposal (RFP) and contract; and the results/lessons learned in implementing the process.

INTRODUCTION - THE PROCESS DEFINED

The Central Tactical Processing Program (CTPP) received authority to proceed on 6 Mar 92 and was contractually awarded less than six months later. The system was purchased with three major events in mind. The purchase of an initial usable system within a very short time frame; purchase of a Limited Operational Capability (LOC) within eighteen months of award; and growth from the LOC to an Initial Operational Capability (IOC). This was to be defined during the period of performance of the contract by engineering analysis, (dependent on available funding), and coordination with Air Force Space Command.

It was decided to purchase the system using full and open competition, pursuant to Air Force Regulation 70-30, Streamlined Source Selection, under the umbrella of a Cost Plus Award Fee (CPAF) contractual arrangement. Due to the limited budget available ($24.5 million), it was decided to provide the budget in the Request for Proposal (RFP) and to allow the successful offeror to determine the extent of compliance with the "A" type or Systems Specification within available funding. This specification was considered a functional specification within the dictates of systems engineering.

The "A" type specification was structured with this in mind. The LOC was documented as a set of firm requirements that the offeror must meet and additional desired capabilities, potentially required for the IOC, were documented as goals. The successful offeror was instructed to provide the LOC within available funding and to determine what, if anything, he could provide of the documented goals within the remaining dollars, assuming projected unused funds remained. His only limitation was to demonstrate the extent of his system's maturity during the source

selection process and to provide an acceptable management plan that would explain how his system would be expanded, without degradation of existing capability, to meet the LOC requirements. This demonstration was designed to preclude offerors from providing a paper product with no basis in fact. It was also designed to provide the Program Director with an understanding of the existing capability that would be provided.

The decision was made to include the Integrated Management System (IMS) as a tool for administering and managing the resultant contract. This system first developed for the F-22 Aircraft and forming the basis for the new Integrated Product Development (IPD) Process being developed by the Air Force, requires that the offeror provide with his proposal an Integrated Master Plan which lays out the major events of the program, accomplishments to complete these events and realistic criteria that will demonstrate these events have been completed. In addition, it requires that the offeror provide an Integrated Master Schedule that identifies how and when these events will be accomplished. The initial submittal of the Integrated Master Schedule was requested with the Request for Proposal (RFP). Subsequent submittals will document the progress of the program and highlight any slips or difficulties that the resultant awardee will experience. Technical Performance Measures were also requested to be identified by the offerors to graphically measure the successful offeror's progress toward meeting identified operational parameters.

Since the decision was made to incorporate the IMS as a tool, the only mandatory delivery date provided to the offeror was the end date of the contract. In addition, a sample development schedule was provided with the RFP to assist the offeror in understanding Air Force expectations.

The Program Director requested the offeror to provide as part of the Integrated Master Schedule, an initial implementation review, a midterm review and a final review. These reviews are considered the Government desired minimum major milestones of the program and allow the Program Director to monitor the offeror's progress.

Early industry involvement was a tenet of the acquisition and industry was involved at the earliest possible time. Industry participation was applied somewhat sparingly however due to the openness of the competition and the projected number of potential offerors. An Electronic Bulletin Board was established and all available documentation was provided to obtain industry comments and feedback on a real time basis. All questions were promptly answered and an Industry Conference was conducted to provide maximum information to all potential offerors. At every step industry was informed that the Government intended they have accountability for the design and that the Government intended to work with them as a team in developing the program. This tenet is also being adhered to today.

The Request for Proposal Process

The RFP was developed with streamlining techniques in mind utilizing a team concept. The idea was to produce a quality, clear, concise document that could be easily understood. The objective was to obtain a proposal that could be awarded without discussion. Specific elements are described below.

Teamwork

The RFP was developed by a team concept. Representatives of all major functional areas were assigned to work with the team

including a program management staff representative. Every member met and participated as part of the team on a daily basis. Each member had an equal voice in the proceedings with the team leader, the Program Director, acting as the point of final authority. The team leader actively sought and accepted input from all the members of the team and often sought confirmation from other members. The initial or core team, which developed the RFP, remained intact throughout the RFP process into contract award with only one exception. After RFP release the Deputy to the team leader was released and the Program Director assumed those duties. The balance of this team remained together after contract award and is currently administering the contract.

In order to stay on schedule and assure that all the team members were actively participating, a template was developed using Microsoft Project that documented every task that needed to be performed and the required completion dates. Each task was then assigned an implementation officer from within the team. Each day this schedule was reviewed to determine if any problems had arisen to cause schedule delays. If something had happened, a work around schedule was immediately developed or, if necessary, additional resources assigned. In this manner the team leader was in constant contact with the activities of the team and problems were dealt with in a timely fashion. Only those activities that were beyond the control of the team itself presented any real problem. These were continually discussed and elevated if possible to resolve. In this manner, the CTPP team was able to develop a schedule for RFP release and maintain that sch dule with little if no difficulty.

RFP Structure

The RFP was experimental in nature and was structured using the principles of the Integrated Management System. The Integrated Management Plan and the initial submittal of the Integrated Master Schedule were requested to be delivered with the proposal on the understanding that the Integrated Master Plan would become a part of the awarded contract and the Integrated Master Plan would be incorporated by reference and subsequent required submittals will document the program. A sample format for Plan and Schedule was incorporated in the RFP to avoid confusion.

Along with these two documents the RFP requested that the offerors provide an explanation in narrative form on those items that would not be specifically identified in the Integrated Master Plan. Particularly the processes that the offeror would use in completing the contract. With the exception of the "A" Specification, the Government provided very few Military Standards or Specifications as mandatory requirements that the offerors had to comply with. Even those that were provided could be tailored by the offeror if he could show adequate cause. It was the preference of the Government that the successful offeror use his own processes in developing the CTPP. One exception to this was the cost reporting.

The offerors were required to implement cost reporting using a Cost Performance Report as part of the contract deliverables. In addition, the offerors were required to use a "flash report" which required the offeror to submit raw cost data five days after the end of the accounting period. This data could then be analyzed on a real time basis to determine if the awardee was overrunning the contract. Actual performance under the contract was to be determined by the use of Technical Performance Measures (TPMs). These measures could be determined after contract award. Progress would then be rewarded

by the designated award fee for a given period.

The RFP structure was based on one numbering system. This system was developed using Military Standard 881 the Work Breakdown Structure (WBS) as the management base. A sample WBS structure was developed to the fourth level and provided for guidance in the RFP. The offerors were allowed to change the WBS structure below the third level providing that a good explanation could be provided and that it fit their intended management structure. There was a conscious effort to match the WBS elements with the products of the program and avoid contractor reallocation of work effort and resultant dollars.

A sample Dictionary was also provided to the offerors for information purposes. Great emphasis was placed on offeror development of a WBS Dictionary that truly represented the intended work package deliverables. The intent of the Government was to use these work packages to trace the funding usage of the resultant awardee and be able to easily match different fund types with work expended. The Dictionary had one further role and that was to document and explain the work that was to be done on the resultant contract. The idea was to have a limited Statement of Work (SOW), with the same numbering system as the WBS, which would only serve as an additional clarification of the necessary work efforts to be performed, but would not stand as a totally separate document. In this way the WBS, the Dictionary, and the SOW were tied together into an integrated package.

The sample SOW provided to the offerors, incorporated the minimum Government requirements that the contractor had to adhere to. The offerors were encouraged to rewrite those portions of the SOW that needed revision to adapt to the offerors processes and proposed program. In this manner the SOW was rewritten by the offerors and had more meaning.

The "A" Specification was also integrated into this numbering system. Each product was clearly identified in terms of functional requirements and specifically identified to the projected WBS elements. This Specification was provided as an attachment to the RFP and resultant contract. In this manner, a RFP cross-reference matrix explaining how the different parts of the RFP worked together became unnecessary. The RFP and resultant contract were fully integrated documents.

To enhance this structure, the data requirements requested by the RFP were kept to a minimum. Only fourteen data reporting requirements were requested in the RFP, including the Integrated Master Schedule, to be delivered as part of the resultant contract.

In addition, the Contract Line Items (CLINS) were tied to the WBS elements. Each CLIN had an identified WBS, Dictionary and SOW requirement. This provided clear traceability of the contractual line item funding to the applicable WBS elements for cost reporting usage.

Since this acquisition was to be accomplished by formal source selection procedures, the evaluation criteria was also tied to the CLINs. Each CLIN therefore, had designated WBS elements for cost tracking, a Dictionary that described the work packages, a SOW that clarified the work effort and evaluation criteria that was used in determining the acceptable design for the program.

The successful offeror's proposal was then made an attachment to the resultant contract so there was no misunderstanding of what the contractor had to offer and what the Government accepted

Contractor Flexibility

The design of this acquisition was to provide the offerors with maximum flexibility. Therefore, the offerors could revise the WBS, the SOW and the Standards/Specifications to match not only the design they proposed, but also the way they intended to manage the program internally. The Government did not want to impose a contractor realignment within the contractor's facility to match the program or, impose new processes on the contractor for performing the contract. The idea was to utilize what the contractor had in place for maximum cost efficiency.

High Fidelity Draft Request for Proposal (DRFP)

At each step of the process the Government desired to have a high fidelity Draft Request for Proposal (DRFP). This DRFP would allow the offerors to begin the formal proposal process with an RFP document that would undergo little or no change. In this manner, the offerors would be able to spend available funding and time on producing a good proposal and not on continuously changing the design to meet changing government requirements.

Instead of issuing a low fidelity DRFP, the Program Director made maximum use of an Electronic Bulletin Board System to incrementally provide available documentation for industry comment. Each document that was to become a part of the final RFP package was put on this bulletin board as soon as it was available. Comments were continuously solicited from industry and periodic updates incorporating resolution of comments were provided for further review. This process provided real time input to the Program Director and allowed industry to participate in development of the RFP documents. In this manner a high fidelity DFRP was issued to industry which assured that the final RFP as issued held no surprises.

Red Team Reviews

At the time of issuance of the DRFP the team decided to hold red team reviews. These were independent reviews of the DRFP itself and were conducted in parallel with other staff and industry reviews. There were three reviews conducted.

The first review was led by the contracting officer and determined whether the RFP was executable, fair, manageable and incorporated correct data. This was considered necessary because the DRFP incorporated sections provided by different individuals and disciplines. It was important to ascertain whether the RFP now played together as a complete document or, whether it was necessary to add some special provisions to clarify or explain the government's intent. The Contracting Officer selected the representatives of the "*Contracting Team*" and comments were forwarded to the RFP team for implementation.

The second review concentrated on the source selection aspects of the RFP. It was led by a project officer and determined whether the right questions had been asked to obtain the desired information in support of the source selection; whether an acceptable source selection plan had been developed to allow sufficient time to complete the competition; and looked at the relative weighting and priorities of the source selection itself. Although specific numerical weights were not assigned (color coding was used), it was important to analyze whether the items were in the correct order of importance, whether the right items had been selected and whether the instructions in the RFP were sufficient enough to garner the answers that would determine the best acceptable offer. The Project Officer selected the representatives on the "Source Selection Team" and

comments were forwarded to the RFP team for implementation.

The third review concentrated on the perception of the RFP from the standpoint of industry. In particular it considered whether the acquisition could be "gamed"; i. e. could the offerors respond in such a way that the government could misunderstand the clear intent of the proposal and thereby select the wrong contractor. It was also concerned with lack of information, lack of consistency, and the relevance of the specifications and standards that had been included. It was clearly understood by everyone that the intent was to award without discussion so the information provided needed to be concise, clear and easily understandable. This was of particular importance since the government chose to limit the amount of documentation that the offerors could deliver. The "Contractor Team" was led by a staff representative and the membership was selected to provide an independent, objective analysis. Membership consisted of staff representatives who had no involvement in the acquisition and independent members from the Aerospace Corporation. The team comments were documented and forwarded to the RFP team for implementation

As a result of the red team reviews it was decided to forego a formal Solicitation Review Board (SRB) process. The in depth review conducted by the smaller red teams was considered more beneficial to the process and served the same purpose.

Budget Provided in the RFP

The requirements of the acquisition did not lend themselves to an easily determined cost estimate. The cost depended on the extent of maturity of the existing system that would be demonstrated. So that the necessary additional requirements for LOC were hard to determine. In addition, the goals of the acquisition were determined to be major cost drivers that could provide a proposal well above the available dollars. Therefore, in order to be fair and open with industry the government budget was provided in the RFP.

It was well recognized that including the budget in the RFP would make the government's job of selecting an offeror more difficult. It became especially important to acquire a well laid out plan and design that could feasibly be provided within the projected dollar amount. The award fee plan criteria was therefore directed at performance to the offeror's management plan, and cost and schedule performance within the dollars provided. This left the offerors with no misunderstanding of the government's intent and ensured a realistic cost proposal would be submitted.

Major Building Blocks (WBS and Dictionary)

The WBS and Dictionary gained significant importance as the process progressed. Not only was the sample structure established as the basic building blocks of the RFP, but it established the numbering system that was carried throughout the "A" Specification, the SOW, Sections L and M of the RFP (Proposal Preparation Instructions and Evaluation Criteria) and the CLIN structure. Each second level WBS represented a CLIN description that could easily be adhered to. The sample SOW tasked against the designated WBS and only included the necessary wording to clarify the intent of the Dictionary language. The Offerors were not allowed to change the second level WBS structure, but could rearrange or group lower level WBS items with revised dictionary language provided the intent of the government was not lost and there was clear understanding of the efficiencies and need involved. The sample WBS was

concurred in by the financial staff prior to RFP release and included as an attachment to the RFP. It was clearly understood that the final WBS of the program would be established during source selection and that no data submission would be required after award of contract to establish an acceptable WBS structure.

Proposal Structured in CLIN Annexes

To further facilitate the source selection process and for ease of evaluation, the offerors were instructed to provide the proposal in CLIN Annexes. A sample format was provided with the RFP that clearly stated how each Annex was to be structured. Each annex not only referred to a CLIN but also to the evaluation criteria for that CLIN. In this manner the evaluators would have complete documentation that serviced each CLIN product of the Contract.

The Offerors were requested to submit each annex in the following format: (1) WBS and Dictionary definition, (2) SOW, (3) references to the "A" Specification, (4) technical/management approach to the program, (5) the Integrated Management Plan for that annex, (6) the Integrated Master Schedule for that annex, (7) the person loading and required tooling/facilities for that annex.

It was clearly understood that it was the government intent to make the proposal an attachment to the contract. Items (4) and (7) however would be added for information purposes only. It was not considered appropriate to limit the offerors with respect to design and person loading. It was fully recognized that the offeror had to have the flexibilit, during design to make changes to accommodate the functional requirements and to assign personnel to accommodate that design. In addition, since the government would not be taking delivery of the "B" or "C" type specifications until the end of the program, the offeror had full configuration control over the process until delivery.

A diagram was also included in the RFP which demonstrated the difference between the way the offerors were used to seeing RFPs structured and the new structure of this RFP. Every opportunity to clarify the government's intent was taken by the RFP team.

Evaluation Standards Directly Relatable to Proposal Preparation Instructions.

Great care was taken to relate the evaluation standards to reasonable expectations for the program. The proposal preparation instructions only requested information on those critical items that made a difference in designing the system that would clearly distinguish one offeror from another in terms of performance capability.

The source selection team was limited to seven evaluators and ten advisors. The evaluators were required to read all of the proposals and assign a color code to each item with inputs from the advisors. Therefore only discriminators were considered necessary inputs from the offerors to make these determinations.

RESULTS AND LESSONS LEARNED

After the source selection was successfully accomplished the RFP team reviewed the process they had undergone and considered those things that could have been done differently or better. A discussion of the results and lessons learned is included below.

Teamwork

It was extremely difficult at first for the team to work together as a team. Each member was from a different background

and had different experience levels. To work together as a team required that some individuals undergo a cultural change.

Each member was from a different functional background and was indoctrinated to following the precepts of that functional discipline. Working together as a group required that some functional requirements be modified and/or reduced to meet the specific needs of the experimental RFP. It was difficult to prevent individual members from harboring "hidden agendas;" i. e. attempting to include in the RFP their own specific requirements attributable to their functional discipline. Once these agendas became self evident however, they were easily dealt with. Long understood requirements were often set aside to meet the needs of the acquisition.

In order to facilitate good communication, it was decided to co-locate the team within the same general area. This became difficult to arrange due to lack of space and matrixing requirements. It was not until this process was well underway that this activity could be accomplished. Once accomplished however, the synergism of the team improved immensely and communication was greatly enhanced.

Another problem that surfaced involved the assigning of work effort. It became necessary, due to the limited membership of the team, to make assignments that were not necessarily based on the expertise of the individual or, within their specific functional area. Therefore, training had to be given in order for these individuals to perform. This required specific one on one training and generated some resistance at first. Some initial team training might have helped this process.

At the conclusion of the process, there was general consensus that everyone had learned a great deal about other functional problems and gained considerably from the experience. There was a general "buy in" to the program as each member became a direct functioning member of the team and fully understood the requirements of all the members. There was also a general consensus that since the requirements were understood there was less tendency for functional experts to require the inclusion of items that would be expensive and of little utilization to the program.

The last positive comment concerned the source selection process itself. Since each member of the team was an evaluator of the proposal, had read and understood the entire RFP, and knew the requirements of the program, it was easier to select the acceptable offer without misgivings and without requiring discussions.

Integrated Management System

While the team felt that this area was adequately covered in the RFP, some difficulty was experienced by responding offerors. It appeared that the RFP failed to provide a good clear definition of success criteria and the example provided in the proposal preparations instructions caused some misunderstanding. In addition, the government did not include in the RFP a clear description of technical performance measures. This was apparent from the fact that no offeror demonstrated a truly clear understanding of what the Government required in this area.

An obvious solution to this problem is of course to provide clearer instructions. However, it was felt that more indepth discussions with potential offerors on a one to one basis would have also helped the situation. Explicit government training would have greatly enhanced the ability of the offerors to respond. Needless to say any future RFP structured along these lines should take this problem into consideration.

Work Breakdown Structure

The responses received form the offerors to

the WBS instructions did not change the basic structure of the RFP. However, the changes that were made lacked explanation, although clearly requested as part of the RFP instructions. In addition, one minor change actually drove the cost reporting instructions to a lower level than was previously anticipated or desired.

There is no obvious solution to this kind of problem, only alternatives that could be considered. One potential alternative would be to have the offerors submit a WBS structure for approval with the DRFP and discuss any problems perceived with that structure prior to formal RFP issuance. This would also allow the financial community to formally approve the offeror's WBS structure. It could however, have the effect of limiting competition to only those offerors with approved WBS structures and could eliminate any offeror who was late in responding or, who had difficulty obtaining WBS approval. Without careful control, this could create a protest situation. Another alternative would be for the Government to choose a WBS structure, as a result of industry inputs, with no allowance for changes. This again is not an optimal solution since it restricts the flexibility of the potential offerors and could in fact favor a specific offeror depending on which comments were incorporated. It is hard to determine which would be the best way to approach the problem. It appears to be a matter of choice.

Statement Of Work

The "Order of Precedence" Provision currently included in FAR and mandatory in all government contracts caused some confusion as to what was more important to the Government, the SOW or the specification. Since both the specification and the SOW were separate attachments, the RFP should have clearly stated that the intent was to have the specification take precedence. Even though the offerors were allowed to change the SOW before it went on contract, it was not intended that the SOW take precedence over the Program Director's "A" specification. The Program Director's intent was to maintain and control the "A" specification and to manage the program at the performance level. When one offeror made his SOW the highest precedence document, this caused some consternation. Particularly since the offeror's SOW could have been interpreted as changing some of the performance requirements. The only possible solution to this kind of problem is for the government to clearly state the order of precedence in the RFP.

Compliance Documents

The offeror's complied with the RFP instructions and proposed their own processes to meet the intent of the military standards or specifications. Unfortunately, while these processes were well documented, it was difficult to determine that in fact the process proposed met the intent of the military standard. It then became necessary to contact the cognizant Administrative Offices and have them confirm that the offerors' processes did in fact meet the Government's intent. In addition, it was found that a subtle manipulation of the wording of a paragraph could in some instances completely change the intent of the requested standard. The government had allowed the offerors the flexibility to tailor the standards, but failed to stipulate that the tailoring had to meet the intent of the existing requirement.

These particular problems could have been avoided with a little forethought. If the offerors had been asked to provide process verification along with their proposal documents, then the government would have been able to instantly verify the validity of a process and possibly build a data base of approved processes. The other

issue could have been resolved if the government had clarified within the RFP that any tailoring of the military standards would meet the intent of the current requirements and require the offeror to clearly identify the tailoring with appropriate justification. Hindsight of course is always easy .

CLINS Tied to WBS

The methodology of tying the CLINs to the WBS had important benefits in that it provided clear traceability from the model contract to the SOW language and the appropriation. However, it became clear that when the offerors were allowed to change the WBS they also had to change the reference in the CLIN language. Otherwise that traceability is lost. Since there were no instructions in the RFP to this effect, some offerors made the changes and some did not.

In addition, although the government provided a SOW scope paragraph, that could not be revised, as part of the minimum requirements of the SOW, the scope of that document did not tie directly back to the CLIN structure. So that when WBS changes affected traceability there was a potential for misinterpretation of the scope of the contract. The scope paragraph of the SOW has direct significance in FAR and ties directly into the "Changes" provision of any resulting contract. A clear understanding of how the CLINs relate to the scope is essential to efficient management of the contract. Providing clear instructions in the RFP and resulting contract as to how the scope of the SOW will be treated will minimize this problem.

Another feature of tieing the WBS to the CLINs was the necessity to create WBS elements to provide meaningful CLIN descriptions The financial community was concerned that this activity would not only create unnecessary cost reporting, but drive cost reporting to a lower than desired level. Since that was the concern, the WBS elements that described individual CLINs were raised to a higher level for clear traceability of appropriations to the individual work packages.

Contract Data Requirements Lists

The government made every attempt to limit the amount of data reporting on this acquisition. However the RFP was silent on whether additional CDRLs would be allowed consistent with SOW changes or, whether CDRL tailoring would be acceptable. This became very clear when both of these events occurred as part of individual offeror's proposals. In fact one offeror elected to tailor out the requirement to provide "flash reports" to the government, a basic requirement of the RFP. This particular report was considered a necessity by the Program Director in managing the contract.

Since CDRL reporting costs the government time and money, it is important to stipulate what the offerors can or, cannot do in regard to tailoring or adding data requirements. It is further suggested that any tailoring be accompanied by full identification and justification for the changes for ease of evaluation.

Evaluation Criteria

The most important thing that became readily apparent was the impossibility of having a meaningful separate management area for evaluation purposes. The Integrated Management System systematically ties technical activities to the management of the program. The processes that support development of the program are described and included as part of the narrative associated with the Integrated Management Plan. Therefore, a technical activity is not fully described unless it has an acceptable plan and schedule. These are

integrated products and not severable entities. A problem can exist however, if sufficient emphasis is not placed on management as an integral part of the evaluation process. Management of the program gets lost in lieu of technical requirements and the decision for award is based purely on technical considerations. This being the case the Program Director was concerned that the management of the program had adequate consideration.

The offerors, as part of the proposal were also asked to document how they would organize their program to support development of the system. The WBS established a structure from which the offerors could develop Integrated Product Teams to manage the program. It was the intent of the government to parallel this structure in some fashion, for ease of communication. The idea being to structure a program that best allowed the awardee and the government to work together in partnership to produce a viable system. Therefore, the management of the program was an integral part of the technical process.

The solution was to evaluate both technical and management as one area of emphasis and create separate items or factors for technical and management activities. The CTPP RFP leant itself to determining management at the factor level. This worked really well in determining the acceptable offeror

CONCLUSION

The CTPP RFP process was a valuable experience in teaming and streamlining the RFP process. The resultant contract was awarded on 3 Aug 92. The source selection was completed in record time and award was made without discussions taking place. Everyone involved in the process agreed that more information and insight had been provided on this acquisition than had ever been available before. As a result this process established a well documented program. A few minor inconsistencies noted by the evaluation team were easily corrected after award of the contract. The same team that created the RFP is currently managing the process and the program is making excellent progress. It is this kind of experiment that helps the government understand what efficiencies will and will not work in a bureaucratic environment. Only time will tell whether in fact this program will be truly successful. It will be interesting to return to this program one year from now and see if the program is still on schedule and within cost.

EXAMINATION OF PSYCHOLOGICAL TYPE AND PREFERRED NEGOTIATION TACTICS AND STRATEGIES OF CONTRACT NEGOTIATORS

John P. Hebert, Captain, USAF
3rd Contracting Squadron
3rd Wing (PACAF)
P.O. Box 875
Elmendorf AFB, AK 99506-0875

Dennis E. Campbell, Ph.D.
William C. Pursch, Ph.D.
T. Scott Graham, Ph.D., Major, USAF
School of Systems and Logistics
Air Force Institute of Technology
Wright-Patterson AFB, OH 45430-6583

Alan J. Meade
Directorate of Contracting
Operational and Central Contracting Division
Aeronautical Systems Center
Wright-Patterson AFB, OH 45433-6570

Abstract

This research identified the psychological types of government and private industry contract negotiators, and frequency of use of negotiation tactics and strategies. Analysis also shows statistically significant differences between industry and government negotiators in frequency of use on 20 out of 33 tactics and five out of eleven strategies, and that contract negotiators as a group are statistically different from the general population in terms of psychological type composition.

Introduction

The negotiation of contracts awarded by the United States Government is an area ripe with mis-perceptions on the part of the American public as to the quality and qualifications of government procurement officials. Federal negotiators are viewed by the public as being at a competitive disadvantage to their contractor counterparts because, if for no other reason, of a lack of experience and training. Indeed, one study indicates that federal contract negotiators are not as well educated or as well trained in the procurement field as their industry counterparts (Mavroules,1991). A 1986 study by Peterson reported that 34% of Air Force Logistics Command (AFLC) contract negotiators did not possess a bachelor's degree (Peterson,1986:30). Catlin and Faenza reported in their 1985 study that 10% of the contract negotiators in the Air Force Systems Command (AFSC -- the organization charged with the responsibility for development and acquisition of major weapon systems for the Air Force) did not have a bachelor's degree (Catlin & Faenza, 1985:38). Catlin & Faenza also reported that 69% of the AFSC negotiators had attended a workshop in negotiations, although the length and content of the workshop(s) were not defined (Catlin & Faenza, 1985:39).

One means by which government negotiators might level the playing field with their better-trained and more experienced industry counterparts, is by the understanding and proper utilization of contract negotiation tactics and strategies.

The use of negotiation strategies and tactics is the focus of many books and research studies on the subject of negotiation (Karrass; Nierenberg; Fisher, Ury & Patton). For the most part, the

authors all agree that the effective and proper use of negotiation strategies and tactics is vital to gain a satisfactory outcome from the negotiation.

To establish a common ground of understanding, the following definitions are presented.

> *Tactic* (Technique) is any specific action, words or gestures designed to achieve both an immediate objective (such as countering an action by the other negotiating party) and the ultimate objective of a particular strategy. (Catlin and Faenza, 1985:99)

> *Strategy* is an organized plan or approach to negotiations from an overall perspective that may be composed of one or more than one tactic. (Catlin and Faenza, 1985:99)

One concern of recent research efforts has focused on personality type and the preference of contracting professionals for particular negotiation tactics and/or strategies. Major Charan Johnstone (1986) studied the relationship of psychological type as measured by the Myers-Briggs Type Indicator (MBTI) to preferred negotiation strategies and tactics of Air Force negotiators. The MBTI is a self-reported survey instrument that indicates a person's preferences, and is a validated, widely accepted instrument for psychological testing. While Johnstone was not able to correlate the two variables, she did offer the possibility that the lack of win-win choices on the survey questionnaire might have led to the lack of correlation (Johnstone, 1986:118).

Determining psychological type for both government and industry negotiators, and the relationship to negotiation tactics and strategies may enable organizations to identify desirous traits for recruiting and training contract negotiators. The significant problem is that the information available to researchers today is inconclusive as to the level of use by contract negotiators of negotiation tactics and strategies. Also, while there have been numerous studies addressing government negotiators, there has been little research investigating contract negotiators in the private sector. There has also been little or no research done comparing the tactics and strategies used by government and industry negotiators. Finally, there has been only one study comparing personality type to negotiation tactics and strategies, and that study was inconclusive. The purpose of this research was to determine a) what negotiation tactics and strategies are used, and how often; b) the relationship between government contract negotiators and industry negotiators in terms of what tactics and strategies are used by each group, and how often; and c) if government contract negotiators, as a population, differ from their industry counterparts in terms of psychological composition. The research questions to be addressed were: 1) What negotiation strategies and tactics are most frequently used by contract negotiators?; 2) What is the personality type composition of contract negotiators; and 3) Is there a difference in negotiation strategies or tactics used by government and industry negotiators? Two other questions used in the research are not addressed in this paper.

Negotiation Tactics and Strategies

While the terms tactic and strategy have their own separate definitions, in reality it is difficult to distinguish whether a certain action is a tactic or part of a strategy (Nierenberg 1986:154).

The one common theme prevalent in the literature concerning negotiation is the importance of tactics and strategies in negotiations. As a result, each formal writing usually contains a minimum of one and many times several chapters on the topic of negotiation tactics and strategies. For example, Chester L. Karrass devotes an entire book, entitled *Give and Take,* to the detailed explanation of the use and importance of two hundred negotiation tactics and strategies. Karrass also stresses the importance of both offensive and defensive strategies in successful negotiations (Karrass, 1974).

Another example of an author stressing the point that the use of tactics and strategies is vital in negotiations is provided by a quotation from *Negotiating To Win*, by Peter Economy.

> Tactics and strategies are an integral part of the long history of negotiation. Whether you choose to use certain techniques or not, you should, at the very least, be familiar with the more prevalent ones. This way you will be prepared to counter their use and better defend your positions. When you negotiate for a living, you need to have every possible tool at your disposal to use in your transactions. (Economy, 1991:179)

While it is apparent that the preponderance of the literature emphasizes the importance of using negotiation tactics and strategies, most authors identify and display a list of tactics and strategies without much guidance on when or how to effectively use strategies (Karrass, Economy and others). One reason for this appears to be the complex and varied nature of each negotiation. As noted by Steele, Murphy, and Russill,

> No general rules can be laid down about tactics. Each negotiation must be considered separately before you decide which tactics are appropriate. It is equally essential to consider the *personalities* and approaches of the other party or parties to the negotiation. A particular tactic will work better on some people than on others. The same tactics will also work differently on the same person in different circumstances or at different times. (Steele, Murphy & Russill, 1989:94)

Preferred Negotiation Tactics and Strategies

Catlin and Faenza identified from a list of given alternatives the five most preferred negotiation strategies and the top ten tactics favored by 278 U.S. Air Force contract negotiators at four separate Air Force Systems Command (AFSC) buying divisions (Catlin and Faenza, 1985:vii). Due to the exploratory nature of their research, Catlin and Faenza could not explain why the respondents answered the way they did. Catlin & Faenza's definitions of negotiation tactics and strategies reflect those of the literature surveyed (Catlin and

Faenza, 1985:7). The U.S. Air Force negotiators from AFSC selected the following strategies, in rank order of preference, from a possible ten choices: *Bottom line; Statistics Participation or involvement; Combination or the big pot ; Step-by-step*

These same negotiators identified their top ten preferences for negotiation tactics from 33 possible choices as: *Ask for lots of data, Belabor fair and reasonable, Split the difference offers, Allow face-saving exits, Off-the-record discussion, Call frequent caucuses, Low-ball offers, Refer to your side's generosity, Escalate to opponent's boss, Escalate to your boss* (Catlin and Faenza, 1985:41).

In 1986, a second study on negotiation tactics and strategies was conducted by Peterson. The difference between the two research studies was that instead of surveying AFSC contract negotiators as Catlin and Faenza had, Peterson surveyed Air Force Logistics Command (AFLC) contract negotiators. The ninety-two responses from the AFLC contract negotiators were similar to their AFSC counterparts and showed a preference for the following negotiation strategies in rank order as: *Statistics, Participation, Step-by-step, Bottom line, and Combination* (Peterson, 1986:43).

Peterson asked the participants to rank order their five most preferred negotiation tactics from the list of 33 possible choices. The same AFLC contract negotiators identified their preference for the top five negotiation tactics as follows: *ask for lots of data, belabor fair and reasonable, split the difference offers, refer to your side's generosity, and allow face-saving exits* (Peterson, 1986:68).

<u>Personality Type Theory</u>

In 1923, the noted psychologist Carl G. Jung published the book *Psychological Types.* Within this publication, Jung detailed his theory of personality types that stated "much seemingly chance variation in human behavior is not due to chance, but is in fact the logical result of a few basic, observable differences in mental functioning" (Myers and Myers,1980:1). Katherine Briggs and her daughter Isabel Briggs Myers, over the course of more than forty years of observation and research, extended and expanded Carl Jung's writing on dominant and auxiliary functions to produce a systematic psychological type theory that integrated the primary and secondary functions.

The cornerstone of personality type theory, as expounded upon by Briggs and Myers, can be summed up in the first paragraph of Isabel and Peter Myers' book, *Gifts Differing:*

> It is fashionable to say that the individual is unique. Each is the product of his or her own heredity and environment and, therefore, is different from everyone else. From a practical standpoint, however, the doctrine of uniqueness is not useful without an exhaustive case study of every person to be educated or counseled or understood. Yet we cannot safely assume that other people's minds work on the same principle as our own. All too often, others with whom we come in contact do not reason as we reason, or do not value the things we value, or are not interested in what interests us.
> Seemingly chance variation in human behavior is not due to chance; it is in fact the logical

> result of a few basic, observable differences in mental functioning. (Myers and Myers, 1980:1)

The differences in mental functioning, referred to above by Myers and Myers, relate to the way that individuals prefer to perceive and make judgments when they are given choices. Each function is characterized by a dichotomous scale on which each individual has a preference for choosing toward one end or the other when given a chance to choose between the two diametrically opposed functions. While certain situations may dictate that one function be used over the other, when given a choice, individuals will show a propensity to exhibit behavior that consistently favors one end of the scale over the other end. In fact,

> Each of us develops a preference early in life and sticks with it. And the more we practice those preferences--intentionally or unintentionally--the more we rely on them with confidence and strength. That doesn't mean we're incapable of using our non-preferences from time to time. In fact, the more we mature, the more our non-preferences add richness and dimension to our lives. However, they never take the place of our original preferences. So, Extraverts never become Introverts, and vice versa. (Kroeger and Thuesen, 1988:11)

The eight dichotomous pairs, are *Extraversion (E)- Introversion, (I) Sensing (S) - Intuitive (N), Thinking (T) - Feeling (F),* and *Judging (J) - Perceiving (P).* Combinations of the different functions result in one of 16 distinct and separate personality types, i.e. ISTJ, ENFP, etc.

The Myers-Briggs Type Indicator

The Myers-Briggs Type Indicator (MBTI) was developed, over a period of twenty years, by Isabel Briggs Myers and Katherine Briggs to specifically carry Carl Jung's theory of psychological type into practical applications. The development of the MBTI survey culminates a lifetime of observation and research by Isabel Briggs Myers in the area of personality types (Lawrence, 1982:5). The main purpose of the MBTI is summarized by Isabel Briggs Myers and Mary McCaulley in their publication, *Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator.*

> The aim of the MBTI is to identify, from self-report of easily recognized reactions, the basic preferences of people in regard to perception and judgment, so that the effects of each preference, singly and in combination, can be established by research and put to practical use. (Myers and McCaulley, 1985:1)

There are two reasons why the MBTI was chosen as a survey instrument in this research. The first reason involves the theory of personality type which proposes that an individual's attitudes and behaviors are identifiable by the way they judge and perceive the world. Since one's choice of a

particular negotiation tactic or strategy is related to an individual's judgment and perception process, it may be reasonable to postulate a correlation between the choice of a particular negotiation tactic or strategy and one's personality type may exist. If such a correlation exists, the possible benefits could be significant. Considering the negotiation process alone, understanding the relationship of personality type and negotiation tactics and strategies may allow the process to be more completely understood if we could predict, or at least understand, why the opposing negotiator is acting or behaving the way he or she is.

The other reason the MBTI was selected for use in this research is that it provides a survey instrument that has been fully tested, refined, and proven valid and reliable over time. Myers and McCaulley provide a history of the actual construction of the MBTI in their MBTI Manual (Myers and McCaulley, 1985:140-146). Their manual also explains that the MBTI's internal reliability, proven through the use of the split-half technique and test-retest correlations, is well established as an acceptable measurement for use in research (Myers and McCaulley, 1985:164-174). The validity of the MBTI has consistently been proven over many years by showing that: the MBTI scores correspond favorably to other survey instruments that measure Jungian constructs, behavior of the MBTI types is in concert with predicted MBTI type theory, and knowledge of type differences contributes to the understanding of other issues of psychological importance (Myers and McCaulley, 1985:175-223).

<u>The Relationship of Personality Type and Preferred Negotiation Tactics and Strategies</u>

Johnstone surveyed 249 out of a possible 508 contracting officers and price analysts in the 1102 job series employed at the Aeronautical Systems Division (ASD) at Wright-Patterson Air Force Base, Ohio. The survey contained two parts, the MBTI and a nine page questionnaire concerning negotiation tactics and strategies. The negotiation questionnaire listed ten negotiation strategies that the respondents ranked by order of preference. Likewise, 33 negotiation tactics were presented whereby the respondent ranked their top five preferences along with listing the top five tactics used by their opponents (Johnstone, 1986:57-60).

Results of the survey were composed of responses from ninety-nine participants of which 69 were male and 30 were female. The MBTI results were paired with the corresponding negotiation questionnaire responses and statistically analyzed for correlation. While the results of the statistical analysis failed to establish a correlation between preferred negotiation tactics and strategies and personality type, it did show that the sample's type distribution was statistically different from the type distribution in the general population. Johnstone noted a preponderance of ISTJ (38.4%), ESTJ (20.2%), and ENTJ (8.1%) in her sample population (Johnstone, 1986:xi-xii).

Johnstone attributes the lack of correlation between the negotiation tactics and strategies and personality types to the negotiation questionnaire which,

> When reviewed in the light of the behavioral sciences' findings in the conflict literature, all belonged to the win-lose or competitive approach. By failing to offer a range of choices that would

have allowed expression of the differing preferences of the psychological types, the questionnaire limited the results to competitive solutions only. (Johnstone, 1986:118)

Johnstone also offered the possibility that the heavily regulated internal and external environments of the federal acquisition workforce may have influenced the way the respondents answered the survey (Johnstone, 1986:119).

Methodology

A mail survey was chosen to accomplish the objective of establishing an information base concerning personality types and preferred negotiation strategies and tactics. The survey instruments for this research consisted of the Myers-Briggs Type Indicator (MBTI) and a questionnaire on preferred negotiation strategies and tactics originally designed by Catlin and Faenza (Catlin & Faenza:23-24) and subsequently modified by the current research team, in which the survey respondents were asked to indicate, using a five point Likert scale, how often they used a particular negotiation tactic or strategy (1 = Never, 5 = Always). Various statistical measures were used to answer the research questions. Demographic results were arrived at using simple mean, standard deviation, and median scores. A comparison to the SRI International Values and Lifestyle Program Survey (VALS) database was conducted using a standard chi-squared statistic to determine statistical differences. A comparison of personality types and major sub-types for government to industry was reported. Some of the research questions were answered by a comparison of means, in a test of hypothesis (Z - test).

Results

A total of 2000 surveys were mailed to National Contract Management Association members in April 1992. Of the original 2000 surveys mailed, 627 usable were returned for a return rate of 31.35%. In all instances where the data are stratified by employer, the 39 respondents that answered 'Other' to the question regarding employer were excluded from analysis, and the sample size reduced to 588 instead of 627.

The demographics portion of the survey consisted of eight questions: Age, gender, ethnic origin, employer, total number of years in contracting, highest level of formal education attained, total number of hours of formal training in negotiations, and percentage of time spent conducting and managing contract negotiations.

Analysis of the age of the respondents shows that 19.9% (125) of the survey respondents are 35 years of age or younger, leaving 80.1% (502) of the population 36 years old or older .

Males represented 66.7% (418) of the survey respondents, compared with 33.3% (209) female . The ethnic makeup of the survey respondents was reported as 93.3% (585) Caucasian, 2.4% (15) Black, 2.2% (14) Hispanic, 0.5% (3) Oriental, and 1.6% (10) reporting Other . The survey showed that 56.9% (357) of the survey respondents were employed in private industry, 34.3% (215) employed by the federal government, 1.6% (10) employed by state government, 1.0% (6) employed by local government, 6.2% (39) reported being employed by other than the aforementioned employers. The majority (59.0%) of contract negotiators

indicated that they possessed more than 10 years of contracting experience, with 22.5% (141) having 11 to 15 years of experience, 23.6% (148) having 16 to 25 years of experience, and 12.9% (81) having more than 25 years of experience. This left 41% with less than 10 years experience; 26.5% (166) having between 5 and 10 years of experience, and 14.5% (91) having less than 5 years of experience .

The education level of the survey respondents is as follows: 3.7% (23) possessed a high school diploma, 12.1% (76) had some college, less than a baccalaureate degree, 38.1% (239) had a bachelor's degree, 43.4% (272) had a graduate or professional degree (i.e. J.D.) degree, and 2.2% (14) possessed a doctoral degree. 0.5% (3) did not respond to the question.

The majority (53.1%) of the negotiators who responded indicated that they had received more than 40 hours of formal training in contract negotiation. 28.9% (181) of the respondents indicated that they had received more than 80 hours of formal training. 0.3% (2) respondents did not indicate their level of training.

Thirty six percent (226) of the respondents indicated that they spent more than 25% of their time in their current position either negotiating or managing contract negotiations. 45.9% (288) indicated that they spend less than 25% of their time in their current position negotiating or managing contract negotiations. 18.0% (113) indicated that they did not currently negotiate in their present position. 0.3% (2) did not respond to the question. A composite survey respondent would be a male caucasian, between 36-45 years old, employed by private industry with 11 to 15 years of experience in the contracting field, possess a master's degree, have received between 20 and 40 hours of formal training on contract negotiations, and spends less than 25% of his time in his current position negotiating or managing the negotiation of contracts.

Because the primary focus of this research is the relationship between government and industry, the data were stratified by employer and analyzed for differences. Only two professional demographics questions showed a statistically significant difference at the $p<.01$ level. Industry contract negotiators indicated that they have more years in the contracting profession (mean scores Industry = 3.02, standard deviation = 1.28; Government = 2.74, standard deviation = 1.19), while government negotiators indicated that they had received more formal training than their industry counterparts (mean scores Industry = 2.73, standard deviation = 1.60; Government = 3.15, standard deviation = 1.55).

Research Question One. ***What negotiation tactics and strategies are most frequently used by contract negotiators?***

The data indicate that all of the negotiation tactics and strategies are used to some extent. The ten most often used tactics are (in descending order of frequency of use, i.e. *Allow face saving exit* was most frequently used, the next was less frequently used, etc.): *Allow face saving exit; Split the difference; Pick and choose the best deals; Bogey - constrained by budget limits; Refer to your side's generosity; Call frequent caucuses; Belabor fair and reasonable; Massage opponent's ego; Refer to other side's past poor performance; and Good Guy - Bad Guy Roles.* It should be noted that the data show negotiators as a whole do not often use tactics that could be construed as negative or unethical in nature. The data also show that there is little or no difference between

government and industry negotiators in terms of what tactics they tend to shy away from. The low standard deviations reflected of the least frequently used tactics also show relative agreement among the survey respondents as to the unappealing nature of the tactic. The ten least frequently used tactics are (in ascending order of frequency of use, i.e. *Adjust the thermostat* was used least often, the next tactic used more that the previous, etc.): *Adjust the thermostat; Deliberately leave errors in offers; Personal attack; Deliberately expose notes or working papers; Reverse auctioning; 'Off the record' discussions; Negotiate with limited authority; and ask for excessive amounts of data.*

The survey respondents indicated that they used the strategies in the following order (in decreasing frequency order of frequency of use) *Win-Win, Statistics - figures don't lie, Participation, Coverage - Bottom Line, Step-by-Step, Combination - the big pot, Definite Action - testing the waters, Limits, Patience - buying time or stalling, Surprise, and Reversal.*

Although the *Win-Win* strategy was shown to be the strategy most often used, the data clearly show that all of the strategies are used to some extent.

<u>Research Question Two.</u> ***What is the personality type composition of contract negotiators?*** The distribution of personality types as measured by the Myers-Briggs Type Indicator (MBTI) are shown at Table 1.

The survey respondents were compared to the SRI International Values and Lifestyle Program Survey to determine if the survey sample was similar to that of the general population.

When the data were stratified by employer, the test shows the two populations are statistically different. Therefore, one can conclude that the composition of personality type as measured by the MBTI for the contract negotiators that responded to this survey is not the same as the that of the general population. Further analysis provided the personality type composition of government versus private industry contract negotiators. It is interesting to note that the government strata had a proportionately higher amount of females in the population than the industry strata, although no explanation is offered. A chi-squared analysis was performed using the larger industry strata as the base to which the government strata was compared. A chi-squared value of 9.1086 was received for males, and 23.3375 for females, indicating no significant differences between the two strata, at the $p < .001$ level of significance.

<u>Research Question Three.</u> ***Is there a difference in negotiation strategies or tactics used by government and industry negotiators?*** There was not a significant difference between the order of use of the particular tactics and strategies. The data did show that the industry negotiators tended towards a higher level of use of specific tactics than their government counterparts.

While there is not a significant difference in the strategies used by both government and industry negotiators, again the data suggests that while government negotiators use negotiation strategies, they do so at a level lower than that of the industry negotiators. It should be noted that the level of use for all of the strategies was higher than that of tactics, regardless of employer. This despite the definition provided to the survey respondents that defined negotiation

Table 1

DISTRIBUTION OF PERSONALITY TYPES OF CONTRACT NEGOTIATORS AS MEASURED BY THE MYERS-BRIGGS TYPE INDICATOR (MBTI)

(n = 627)

ISTJ	ISFJ	INFJ	INTJ
N = 151 % = 24.1	N = 3 % = 0.5	N = 3 % = 0.5	N = 33 % = 5.3
ISTP	ISFP	INFP	INTP
N = 101 % = 16.1	N = 5 % =0.8	N = 7 % = 1.1	N = 63 % = 10.0
ESTP	ESFP	ENFP	ENTP
N = 79 % = 12.6	N = 20 % = 3.1	N = 10 % = 1.6	N = 47 % = 7.5
ESTJ	ESFJ	ENFJ	ENTJ
N = 83 % = 13.2	N = 7 % = 1.0	N = 1 % = 0.16	N = 14 % = 2.2

NOTE: Percentages rounded off to the nearest tenth.

strategy as "*an organized plan or approach to negotiations from an overall perspective that may be composed of one or more than one tactic*" (Catlin and Faenza, 1985:99). A test of hypothesis was conducted to determine if statistically significant differences exist between the two groups in terms of how often each group used the respective tactics and/or strategies. The same test statistic (paired *z*- test) was used as in previous analyses. The data was stratified by employer, excluding respondents who answered Other to the question. Respondents who reported Federal, Local, or State Government were grouped as the government negotiators, and respondents who answered Industry were grouped as such. The analysis shows that 25 significant differences between the groups exist, 20 tactics questions, and 5 strategy questions. One would expect to find that government negotiators would use *Appeal to Patriotism, Impose No Smoking Rule,* and *Low Ball* tactics more often than industry negotiators due to the nature of the respective environments (federal versus commercial contracting), and that industry negotiators would use *Pick and Choose the Best Deals* and *High Ball* tactics more often. This is in fact borne out by the data.

Discussion of the Conclusions

The objectives of the research were to determine:

> A) what negotiation tactics and strategies are used, and how often;
>
> B) the relationship between government contract negotiators and industry negotiators in terms of what tactics and strategies are used by each group, and how often;
>
> C) if government contract negotiators, as a population, differ from their industry counterparts in terms of psychological composition.

The research objectives were met via the answering of the research questions. It was established that various tactics and strategies are used by contract negotiators, and that they are used in varying frequencies. It was determined that industry contract negotiators report more frequent use of negotiation tactics and strategies than their government counterparts (that is to say industry contract negotiators recorded more responses in the *Sometimes, Frequently,* and *Always* range than government negotiators). It was also established that the government and industry negotiators are similar in terms of personality type distribution (psychological composition).

It can be seen that contract negotiators use the identified negotiation tactics and strategies. Conversely, the sample indicated that they did not use other negotiation tactics as often. Of the negotiation strategies, the sample indicated that all were used more than *Seldom,* and in fact all but two were used more than *Sometimes.* The negotiation strategies most often used are *Win-Win* a.d *Statistics,* with the least used being *Reversal* and *Surprise.*

looking at the personality type distribution of contract negotiators, it was found that the negotiators have a unique distribution, heavily favoring the *ST* (*Sensing-Thinking*) functional grouping, with a marked under-representation of *Feeling (F)* types. This distribution is similar to that found in Johnstone's study (Johnstone, 1986). The sample was compared to the general population as personified by the SRI database, and found to be statistically different from the general population.

When analyzing the differences between government and industry negotiators in terms of frequency of use of negotiation tactics and strategies, it was established that industry negotiators used tactics and strategies more often than their government counterparts across the board. Ranking the mean scores of the ten most frequently used tactics and strategies by both strata yielded little significant difference in terms of which tactics were used most often by the two strata. Statistically significant differences were established between government and industry negotiators on 20 out of 33 tactics, and 5 out of eleven strategies, leading to the conclusion that the two groups are not the same in terms of now often each tactic or strategy is used.

Discussion

Overall, the research objectives were satisfied. The purpose of this research was to determine differences between government and industry contract negotiators in terms of what negotiation tactics and strategies are used, how often they are used, and the relationship of personality type, as measured by the

Myers-Briggs Type Indicator, to use of negotiation tactics and strategies. This research established the fact that negotiation tactics and strategies are used by contract negotiators, in both government and industry. The impact of the use of the various tactics and strategies, however, is unknown. A study to examine the relationship between tactic or strategy used and negotiation outcome would provide invaluable information to contract negotiators. It would then be possible to pick appropriate negotiation tactics or strategies that would ensure a more favorable outcome.

The National Contract Management Association has made large inroads into the education of its members in terms of negotiation and the use of tactics and strategies. However, as this research showed, some tactics are used that are clearly not in the best interests of either party in a negotiation, such as *Personal Attack* and *Embarrass Your Opponent*. While the mean scores indicating frequency of use of the particular tactics were low (less than 2.0), there were individual contract negotiators that indicated that they used the tactic more than Sometimes. This indicates that some NCMA members are choosing to ignore the valuable training provided by NCMA in their educational workshops, or some members did not partake of the training. In any case, it is in the best interests of the NCMA to continue its aggressive stance on education in terms of negotiation. A well-educated membership reflects on the organization.

Congressional and Presidential Commissions findings to the contrary, this research found that government contract negotiators, while less experienced than their industry counterparts, are better trained in the 'science' of negotiation. This research also found that government negotiators are likely to use certain negotiation tactics and strategies, in particular those that are government unique, such as *Appeal to Patriotism*, *High Ball* versus *Low Ball* tactics, along with the *Win-Win* and *Statistics* strategies. However, with the exception of a few of the negotiation tactics and strategies that are specific to the government such as those listed above, government negotiators across the board used tactics and strategies less frequently than their industry counterparts. It would benefit government contracting agencies if it were possible to identify what tactics and strategies are effectively used in certain scenarios, and also to identify their impact on final contract settlement. We also strongly recommend that organizations use the Myers-Briggs Type Indicator in building their negotiation teams. This research established that negotiation tactics and strategies differ between personality functional types. Negotiators will be better off in conducting a negotiation if the negotiator understands his or her teammates in terms of preferences, and can work towards more satisfying conclusions in the negotiation process.

Captain Hebert and Mr. Meade conducted this research under the advisement of Drs. Campbell, Pursch and Graham while graduate students at the Air Force Institute of Technology in 1991-92. Their award-winning thesis, "Examination of Psychological Type and Preferred Negotiation Tactics and Strategies of Contract Negotiators" is on file with the Defense Technical Information Center.

Bibliography

Catlin, Capt Robert M. and Capt Bernard J. Faenza. *Identification of Negotiation Tactics and Strategies of Air Force Contract Negotiators.* MS thesis, LSSR 85S-12. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1985 (AD-A160835).

Economy, Peter. *Negotiating to Win: A Manager's Handbook.* USA: Scott Foresman Professional Books, 1991.

Fisher, Roger et al. *Getting to Yes* (Second Edition). New York: Penguin Books, 1991.

Horton, Captain William R. *Analysis of Negotiation Effectiveness Within Aeronautical Systems Division of Air Force Systems Command.* MS Thesis. AFIT/GLM/LSM/87S-36. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1987 (AD-A188096).

Johnstone, Major Charan M. *Psychological Type and Analysis of Preferred Negotiation Strategies and Tactics of United States Air Force Contract Negotiators.* MS thesis, GLM/LSM 86S-36. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1986 (AD-A174615).

Karrass, Chester L. *Give & Take: The Complete Guide to Negotiating Strategies and Tactics.* New York: Thomas Y. Crowell, Publishers, 1974.

Kroeger, Otto and Janet M. Thuesen. *Type Talk.* New York: Delacorte Press, 1988.

Lawrence, Gorden. *People Types and Tiger Stripes.* Gainesville FL: Center for Applications of Psychological Type, Inc., 1982.

Mavroules, Nicholas. "Creating a Professional Acquisition Workforce," *National Contract Management Journal, 24*: 15-23 (1991).

Myers, Isabel Briggs and Peter B. Myers. *Gifts Differing.* Palo Alto CA: Consulting Psychologists Press, Inc., 1980.

Myers, Isabel Briggs and Mary H. McCaulley. *Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator (Second Edition).* Palo Alto CA: Consulting Psychologists Press, 1985.
Nierenberg, Gerard I. *The Complete Negotiator.* New York: Berkley Publishing Group, 1986.

Peterson, Capt Terry L. *Examination of Negotiation Tactics and Strategies of Air Force Logistics Command Contract Negotiators.* MS thesis, GLM/LSQ 86S-58. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1986 (AD-A175042).

Reck, Ross R. and Brian J. Long. *The Win-Win Negotiator.* New York: Pocket Books, 1987.

Steele, Paul et al. *It's a Deal: A Practical Negotiation Handbook.* New York: McGraw-Hill, 1989.

EXPERT PRICING SYSTEMS

by
Richard J. Hernandez, CPCM
Vendor Programs, Diversity Development Department
U.S. Postal Service

Abstract. This paper discusses the use of rule-based expert systems, a form of artificial intelligence (AI), as a means to improve the speed, quality, and accuracy of the contract pricing function. Expert systems are capable of improving efficiency, as well as effectiveness, since they possess an additional knowledge element not found in electronic spreadsheets. The additional knowledge element is essential given "the complexity of today's business environment is increasing faster than human skill." (1) Rule-based expert systems work by asking human users a series of questions, which in turn use rules, historical data, and computer logic to help humans solve complex problems. There are many potential pricing-related microcomputer-based applications for this new type of technology such as: contract negotiations (helping buyers and sellers set targets), budgeting, feasibility analyses, and establishing a reliable corporate pricing data base.

Introduction. Pricing is an integral part of the contract management process, the results being used to determine if a "fair and reasonable" price or "best value" has been achieved. However, the quality of a cost/price analysis can vary considerably, depending on the skill, experience, and knowledge of the individual estimator or cost/price analyst. Pricing is done using one or more of the following techniques: parametrics (rough yardsticks such as correlating cost to weight of an aircraft), analogies (comparing prices of similar items/systems), using past bids, and/or engineering estimates. Developing a sound corporate pricing expertise, for a private company or a government Agency, can be difficult given the extensive training and time required for an individual or work group to achieve a satisfactory level of proficiency.

The most common pricing automation tool in use today is the electronic spreadsheet. These systems improve efficiency by automating the mechanical calculation of rows and columns of numbers. Some advanced systems also provide multi-dimensional computational capability, regression analysis, forecasting, audit trail capability, as well as impressive graphical displays. Many spreadsheets are able to exchange data with each other as well as with other applications such as data base utilities. However, unlike expert pricing systems, spreadsheets do not improve the effectiveness of the cost/price estimation process.

Overview of Expert System Technology. Expert systems were first conceived in the late 1950s. The term "expert system" was derived since these traditional, rule-based systems perform in a similar manner

as human subject-area experts in that they give advice, make predictions, and solve problems. Recently, case-based reasoning tools have begun making advances in areas where rule-based expert systems are not applicable. Since there has been little application of case-based reasoning to date, this paper will deal exclusively with rule-based expert systems. Expert systems are composed of two essential elements. First, there is a knowledge base, which is usually limited to a specific area or domain. Second, there is an inference "engine" or system which performs the actual problem solving. Expert systems use heuristics, or rules of thumb, when they operate. It is important to note "Expert systems are based on the idea that rules are an effective way to tell computers how to do certain kinds of things that people do." (2) Unlike conventional computer programming languages such as FORTRAN, COBOL, or BASIC, expert systems use advanced programming languages such as LISP, PROLOG, and C which permit the creation of new algorithms to solve a variety of problems. Conventional programming languages do not have this inherent flexibility. A further comparison of expert systems versus traditional computer-based information systems is provided below:

> Expert systems are in general less well defined than information systems, and their role is less precise. They are 'open' and need to be able to respond to *changing environments*, they handle incomplete information and imprecise information, they cannot be fully tested and it is difficult to define exactly how they behave even after they have been built. In many instances the users of expert systems are professional people who are used to making important decisions on the basis of incomplete or imprecise information. The systems are often intended for judgmental tasks which are central to professional jobs. (3)

Expert systems take advantage of the computer's ability to use symbols as well as make numerical calculations. Knowledge engineers help bridge the gap between programmers and users (domain specialists) when developing expert systems.

The advent of a new and low-cost generation of microcomputers in the late 1980s and early 1990s has given rise to a proliferation of expert system applications. Consider the following:

> Tasks such as figuring out how to turn on a lamp require so many rules and so many facts that computers big enough for worthwhile reasoning were not available until the early 1980s. Throughout the 1970s it cost several

million dollars to buy a computer big enough to run even the smallest AI programs, so few organizations had any interest in AI at all. (4)

In fact many vendors sell expert system kits which are know as "shells." These commercially-available shells provide a do-it-yourself development tool for expert system application designers where users add the appropriate decision rules. It should be noted: "A shell has a rule system, a rule editor, and tools for maintaining and debugging rules and facts." (5) Many of these shells are available for under five hundred dollars.

Benefits of using expert systems for contract pricing are: increased accuracy of estimates; improved productivity of buyers and cost/price analysts; consistency; reduced overhead costs since fewer people are required to prepare the cost or price estimate; and increased competitiveness. For small firms the above advantages could also mean expert system can help with better leveraging personnel and knowledge resources, the result being a leveling the playing field between large and small businesses. Expert systems can also serve as a teaching aid for new contract specialists or cost/price analysts. This allows senior price analysts to spend their time working more complex problems or, in the case of contractors, using them for high-skill jobs, which typically yield a higher profit margin or involve a greater risk.

Applications. This section discusses practical applications of real-world expert pricing systems in the areas of hazardous waste cleanup, logistics, and weapon system acquisition. Examples of some of the systems this research effort will examine are: 1) Logistics Expert System Advisor, 2) Superfund Cost Estimating Expert System, 3) Cost of Remedial Action Model, and 4) Logistics Planning and Requirements Simplification System.

Logistics Expert System Advisor (LESA). This microcomputer-based system, developed by Intellogistics in Columbus, OH, helps managers determine the feasibility of using an expert system for a particular logistics application. LESA provides a rough order of magnitude cost estimate as well as return on investment. Users must answer either fill-in-the blank or multiple choice questions.

There are three specific types of cost estimates for the logistic expert system: development, fielding and maintenance. All costs are rounded to the nearest thousand dollar level. Development costs are broken down by personnel, hardware, and software. Personnel costs are the product of the number of persons required to develop the expert system, their salary, labor burden (such as benefits and taxes), and the number of years required to develop the system. The user manual provides an additional explanation on how development costs are calculated:

> Development costs are fundamentally the sum of the sunk costs plus the product of the variable costs over time. The sunk costs are the expert system tool cost and hardware costs (if any), while the variable costs are the personnel costs. The development costs which LESA displays do not include the costs of coding any external interfaces or databases nor the purchase fees of any required database software which the expert system may require. (6)

The guide also notes: "The cost of the expert system software is based on the least expensive tool known to LESA that is compatible with the hardware and software (operating system and database) constraints you set forth when answering the questions about hardware, operating system, and database requirements." (7) Additional notes about determining development costs are that personnel costs are determined by experience levels of the developers. Users have the option to change salary levels depending on the situation. Development costs also include the preparation of documentation. Fielding costs are also determined based on the least expensive computer configuration; they also include such items as travel and installation. Maintenance costs are based on the number of users supported, hardware, and software costs. LESA also identified the time period associated with the maintenance costs. The LESA guide identifies a key limitation: "One limitation of LESA is that it correctly considers only one configuration at a time." (8)

Besides providing a cost estimate, LESA also provides a schedule estimate, a recommendation on whether or not to proceed, the probability that the expert system will success, and hardware/software recommendations. Other useful features are an "accelerator" key which speeds up LESA functions as well as the ability to saves a consultant with the expert system and resume it at a later time.

Superfund Cost Estimating Expert System (SCEES). This microcomputer-based system is used by the U.S. Environmental Protection Agency (EPA) to estimate hazardous waste clean up costs associated with the "Superfund" effort. Specifically, SCEES is used to estimate Remedial Investigation and Feasibility Study phases of toxic waste site clean up at landfills and lagoon/waste pits. The system was developed by an EPA contractor using the Nexpert Object expert system shell. PC AI magazine describes a sample SCEES operation:

> SCEES dynamically creates objects during processing. This is especially useful when dealing with well installation, one of the most expensive site investigation activities.

> Investigators use wells to sample underlying aquifers (underground layers of water bearing rock, sand, or gravel) and thus determine the extent of groundwater contamination.
> Installation cost depends on how deep and through what geologic materials (layers of sand, clay, rock, etc.) well must be drilled, and on the well casing material (pvc, stainless steel). To calculate this cost, SCEES constructs its own model of the site geology. As it collects the information needed to estimate the drilling subtask, SCEES dynamically creates *aquifer* objects (representing layers of geologic materials) and *well* objects. (9)

SCEES makes its estimates using heuristic rules used by human experts, factual knowledge, unit costs, cost trends, and past costs. To further improve accuracy, users have the capability to enter site-specific data. SCEES also provides the ability to examine cost cutting options associated with toxic waste cleanup efforts. Other data provided by SCEES is a cleanup schedule estimate and risk assessment/description. According to PC AI, "SCEES has been delivered to all ten EPA Regions, as well as to groups in the Department of Energy and the U.S. Navy. (10) The magazine also notes SCEES was successful tested by independent evaluators. To improve its future utility, SCEES may be modified to allow it to consider other types of cleanup site situations such as buildings or tank/drum sites.

Cost of Remedial Action (CORA). This microcomputer-based system is used to estimate the cost of remedial actions at EPA Superfund sites. CORA has been in use since 1987, with Version 3.0 being released in May 1990. The system is composed of two basic parts: an expert system and a cost system. The expert part uses the Level 5 expert system shell and the cost part uses Database III Plus. The parts operate independently. CORA is designed for stand-lone operation on a microcomputer. The CORA is described in detail below:

> The CORA cost system is used to develop order-of-magnitude cost estimates (-30% to +50%) for hazardous waste site remediation following the development of response action scenarios, using the expert system or other sources. The CORA cost system organizes cost estimates by site, operable unit, scenario, and technology. The system and the user interact to complete cost model data requirements for a site previously entered

into the database or for a new site. The CORA cost system calculates capital and first-year operation and maintenance (O&M) cost estimates for each of the 40 technologies which may be selected. The user may save cost outputs to a database for subsequent analysis. In addition, the CORA model generates a total summary report for a site or operable unit for both capital and O&M costs. The summary report includes costs incurred by construction and operation of individual unit processes and operations, costs for items such as site preparation and administration, startup, permitting and legal services, permit and insurance renewal, services during construction, and bid and scope contingencies. (11)

According to a HAZMACON 89 research paper, the CORA expert system consists of 670 hazardous waste cleanup-related decision rules for 40 technologies. The system allows the user to combine technologies as part of the corrective action. The cost system component of the CORA model contains 40 primary cost modules. These modules organize the cost estimate by site, operable unit, scenario, and technology. The system uses default values for its cost models; these can be adjusted depending on the specific site situation. The model contains the following cost modules: Removal, Containment, Treatment, Disposal, Auxiliary (e.g., contingencies and site preparation/administration), and Miscellaneous (e.g., transportation and user-supplied costs). Potential future enhancements to CORA are budgeting forecasts and anticipating costs of new environmental regulations. (12)

Logistics Planning and Requirements Simplification System (LOGPARS). This microcomputer-based system, developed by the Material Readiness Support Activity (MRSA) of the U.S. Army Material Command, is used to develop logistic plans, schedules, statements of work, warranties, and contract data requirements lists for weapon systems. LOGPARS also contains a cost adviser module, which estimates the cost of Logistics Support Activity (LSA) services. The user manual notes:

> The cost estimation is done in accordance with MRSA 700-11, Cost Estimating Methodology for Logistics Support Analysis (CELSA). The Cost Advisor implements the CELSA Guides cost estimating methodology to estimate the cost of LSA tasks which are recommended by LOGPARS, specified as being contractor

> executed, and are not specified as already being completed. The Cost Advisor produces a report which lists the LSA task numbers, titles, man-hour estimates, and total cost. (13)

To use the Cost Advisor, users must define cost variables, change "scalers" (used to adjust man-hour estimates), when required, and then request the system perform its calculations. When performing calculations, the system uses man-hour estimate tables, which the user must select. LOGPARS also allows for user-defined scalers. A "Screen Help" feature which explains the questions asked by the system. Currently, only the cost of services can be estimated. However, in the future, the LOGPARS cost module will include Integrated Logistics Support costs.

Rule-based expert systems are not the only form of AI that may advance contract and pricing activities. Case-based reasoning technologies may also offer benefit in the near future. A form of case-based reasoning, Associative Reasoning, has been applied to development of a prototype application enabling the selection of estimating analogs from a historical database of appropriate parameters.

Dr. F. N. Burt, the creator of the patented technology applying Associative Reasoning, states:

> Human judgment is the process of Associative Reasoning (reasoning by comparison with a selected set of past examples which illustrate the logic appropriate to the issues raised by the current example) around the combination of characteristics that makes a given example an exception to rules or to probability. (14)

Within a presentation at the ISPA 1990 Annual International Conference, Dan Walkovitz and Charlie Hopkins describe this concept in a practical fashion:

> The Judgment Processor (a tool embodying the concept of Associative Reasoning) falls within the category of expert systems software. Unlike other expert systems tools, however, this software is not rule-based. Rule-based software demands that the rules be defined by the expert up front. Experts do not, in fact, even know the rules that they apply ...
>
> Experts do not make their decisions according to rules. As a matter of fact, expert break rules set by others. They use insight and intuition, and apply these through the use of judgment which enables them to make

> decisions from "gut feelings" which turn out to be correct more often than similar feelings by non-experts. (15)

This concept of judgment is, in fact, captured by Judgment Processor and its next generation product, Decision Maker. The ability of this technology to capture judgment without the definition of rules and to "reason" or extrapolate beyond the cases it has seen appears to offer great potential beyond rule-based technologies in the contract and pricing domain.

Workplace Implications. There are several key "people" issues associated the introduction of expert pricing system technology into the contract management work place. Currently, most contracting offices have separate support offices that perform contracting pricing. However, providing expert pricing system technology at the individual contracting officer/buyer level could fundamentally alter the need for a separate pricing support office. Expert system technology has the technology to allow buyers to perform many pricing functions by themselves - with considerable speed and accuracy. To maximize the advantage of expert pricing systems, buying teams might be used that do all purchasing-related functions, to include pricing. If a separate pricing office was to be maintained then expert systems would drive up the standards for productivity, accuracy, and timeliness of estimates.

Expert pricing systems could also alter the composition of staffing in contracting offices. Similar to other situations, expert systems allow better leveraging of organizational resources by permitting a shift in the workload from higher to lower level experienced personnel. This leveraging is one way to address the recurring problem of loss of expertise due to high turnover of skilled contracting personnel. For contractors, leveraging means being more competitive by reducing the cost of acquiring subject-area expertise. The concept of leveraging is summarized below:

> The aim of many expert system projects is to encapsulate knowledge about a circumscribed task so that, instead of junior staff bothering their seniors by asking them to solve routine problems, the juniors can do it for themselves with the aid of the system. This enhances their sense of responsibility, allows the experts to apply themselves to more interesting problems, and may result in a more thorough and more consistent approach to the problem than the frustrated experts ever provided. (16)

The expanding use of expert pricing systems may also lead to concerns about de-skilling of buyers/pricers

since some managers and personnel classifiers may believe they are redundant compared to the computer. To address this issue, it is important to realize expert pricing systems are intended to assist, not replace, their human counterparts. Expert human analysis and evaluation will still be required in many cases. However, the productivity of those performing the price and cost estimates will improve significantly using the new technology.

A final work place concern is accountability for errors or omissions. Consider the issue of determining legal liability in cases where certification of cost and price data is required by Government contractors. Or in case of the Government, if a problem such as major cost overrun occurs when using an expert pricing system, it is not clear who should be held accountable, e.g., the cost/price analysts, the programmer, the contracting officer, or the software vendor. Care should be taken to ensure expert systems are not used to second guess human cost/price analysts. Contract managers should also ensure overreliance on the expert system does not occur. Users also need to understand that problems may occur if they attempt to use the expert pricing system outside its range of knowledge or if they do not account for geographical variations in the prices of good and services.

There is more to expert pricing systems than just automating a set of rules for obtain cost/price estimates. There are significant implementation issues which accompany the introduction of this new technology into the contract management workplace. For successful use of this new technology, these issues must be addressed as part of the technical solution.

Summary and Conclusions. Artificial intelligence is a new, and largely unharnessed, technology in the contract management profession. However, expert pricing systems may be a primary vehicle for "mainstreaming" the use of AI in the contract management workplace. The use of expert system technology will become more widespread as the cost of microcomputer hardware is reduced. Another key cost incentive to use expert systems will be to save money by better leveraging personnel resources by shifting knowledge-related work from higher to lower level specialists; this is an important consideration given the need to retain corporate memory in critical business areas/programs. The impact of cost will continue to drive the use of expert systems for many business applications in addition to the contract pricing function.

As a way to improve the utility of expert pricing systems one could reasonably expect innovations such as pre-prepared modules for certain types of work, e.g., professional services, construction, and research and development. Another useful improvement would be the use of electronic data interchange to automatically keep the expert pricing system updated, e.g., for market changes or geographical price variations. Use of EDI would also

improve accuracy as well as minimize buyer/price workload. One key benefit of expert systems might be a leveling of the playing field between large and small businesses when it comes to pricing proposals and contract modifications.

Contract managers and cost/price analysts, in addition to maintaining proficiency with the FAR, its implementing directives, and industry trends, will also be required to improve their automation skills to successfully cope in the 21st century contracting office. Expert pricing systems are a leading application toward the realization of the highly-automated contracting office of the future. The change may not be easy given the tradition of evolutionary acceptance and implementation of new automation tools in the contract management work place. Managers and users need to realize achieving a payback takes time, both in term of learning curve and refinement/updating of the expert system. For those with patience, the sustained long-term rewards of using expert pricing system technology can far exceed the initial investment.

Author's Note: Special thanks to Mr. Dan Walkovitz, President of Mainstay Software Corporation in Denver, CO, who served as a reviewer of this research paper.

The opinions expressed in this article are solely those of the author.

Bibliography

1. Rappaport, Alain and Smith, Reid, Innovative Applications of Artificial Intelligence 2, AAAI Press, 1991, p. xi

2. Taylor, William A., What Every Engineer Should Know About Artificial Intelligence, The MIT Press, Cambridge, MA, 1989, p. 143-144

3. Berry, Dianne and Hart, Anna, Expert Systems: Human Issues, The MIT Press, Cambridge, MA, 1990, p.12

4. Taylor, William A., What Every Engineer Should Know About Artificial Intelligence, The MIT Press, Cambridge, MA, 1989, p. 69

5. Taylor, William A., What Every Engineer Should Know About Artificial Intelligence, The MIT Press, Cambridge, MA, 1989, p. 196

6. Logistics Expert System Advisor User's Guide, Intellogistics, 1990, Columbus, OH, p. 3-2

7. Logistics Expert System Advisor User's Guide, Intellogistics, 1990, Columbus, OH, p. 3-2

8. Logistics Expert System Advisor User's Guide, Intellogistics, 1990, Columbus, OH, p. 1-4

9. Ketterer, Nancy L. and Buehler, Royce E., "The Superfund Cost Estimating System," PC AI, July/August 1992, p. 65

10. Ketterer, Nancy L. and Buehler, Royce E., "The Superfund Cost Estimating System," PC AI, July/August 1992, p. 67

11. U.S. EPA Publication No. 9375.5-06a/FS, "The Cost of Remedial Action Model," Office of Solid Waste and Emergency Response, May 1991

12. Biggs, Richard K., Klink, Kevin, and Crenca, Jacque, "The Cost of Remedial Actions (CORA) Model: Overview and Applications, Proceedings of the HAZMACON 89 Conference, Santa Clara, CA, April 1989

13. LOGPARS User Handbook Version 3.0, USAMC Material Readiness Support Activity, Lexington, KY, 1992, p. 102

14. Burt, F. N., Praxis Business Plan, San Diego, CA, March 1993

15. Walkovitz, Dan and Hopkins, Charlie, "TQM the Estimating Process," Journal of Parametrics, International Society of Parametrics, Germantown, MD, October 1990, p. 125

16. Wyatt, Jeremy and Emerson, Peter, Expert Systems: Human Issues, The MIT Press, Cambridge, MA, 1990, p. 65

Modeling and Simulation for Future Bus Architecture

Patricia Hoffman, SPAWAR 421

ABSTRACT

The scope of Modeling and Simulation has broadened significantly during the last few years. Modeling and Simulation has been applied to many areas to which it was never before associated. This increase in applicability of Modeling and Simulation has enabled many different groups to use it in new and interesting ways. One of those ways was the innovative use of simulations to evaluate the suitability of a communications protocol to a specified Bus architecture. The topic protocol was the IEEE Futurebus+ protocol which was under development at the time of the simulation. This was perhaps the first time that simulations were used to test the suitability of a draft standard for a particular architecture.

INTRODUCTION

The scope of Modeling and Simulation has broadened significantly during the last few years. Modeling and Simulation has been applied to many areas to which it was never before associated. This increase in applicability of Modeling and Simulation has enabled many different groups to use it in new and interesting ways. One of those ways was the innovative use of simulations to evaluate the suitability of a communications protocol to a specified Bus architecture. The topic protocol was the Futurebus+ protocol which was under development at the time of the simulation. The method of evaluation included simulation as no hardware existed at the time of the study. Futurebus+ was still in the early stages of development.

This paper describes the modeling and simulation effort which supported the evaluation of the Futurebus+ protocol. A brief description of Futurebus+ will be included, followed by the steps taken during the course of this evaluation, and then a summary of some of the lessons learned during this project.

FUTUREBUS+

The Futurebus+ protocol is defined in the P896 series IEEE Protocol Standards. Futurebus+ provides the means for the transfer of binary information between boards over one or more logical buses. Boards may contain any combination of one or more processors and local resources such as cache, memory, peripheral and communication controllers, etc. The logic protocol is defined for the allocation of bus time to processors which need to communicate with other modules over the bus. The Futurebus+ set of protocols was designed to be as technology-independent as possible without damaging the performance and a very high level of efficiency. Many different technologies may be used when implementing the bus signals (TTL, Backplane Transceiver Logic, ECL, CMOS, etc.) as long as the Futurebus+ signaling conditions are met.[1] Futurebus+ is an open architecture protocol with features such as scalable bit width (32/64/128 or 256 bits wide), central and distributed arbitration, cache coherency, and live insertion; to name a few. Any implementation that meets the Futurebus+ protocol standard is a Futurebus+.

PROJECT DESCRIPTION

The objective of this project was to evaluate the performance of a defined bus architecture that used Futurebus+ as the communications protocol. The goal was to examine the ability of this bus to achieve less than 10% bandwidth utilization.

Before going into the actual modeling and simulation of Futurebus+, a brief description of the tool used for this project will follow. This will enable a better understanding of the specifics of the model. The tool of choice for the modeling and simulation of Futurebus+ was OPNET™. OPNET™ is a Computer Aided Engineering (CAE) tool which is developed by MIL3, Inc., a firm located in Washington, D.C. OPNET™ is an event-driven simulation tool. Models are defined using a hierarchical approach. The top layer is the Network Layer which defines the topology or layout of the architecture to be modeled. The next layer beneath the Network Layer is the Node Level. The Node Level describes the functions of each of the processors defined at the Network Level. Several types of nodes are provided in OPNET™'s extensive library. These include a fixed communication and mobile communication node type, several predefined data generators, and several types of queue nodes. Beneath the Node Level is the Process Level. The Process Level is defined using state diagrams for each of the nodes defined in the Node Level. Contained in each "bubble" of the state diagram is C code. This C code is written in code fragments and the tools provided with OPNET™ produce a complete C program based on all information contained throughout the three outer layers. The brief description of OPNET™ having been completed, the actual model description will follow.

The modeling effort was completed in 6 phases or steps. These phases were: 1) Definition of the architecture to be modeled, 2) Study of the IEEE Futurebus+ Draft Specifications - P896.1 (Logical Layer Specification), P896.2 (Physical Layer Specification) and P896.3 - (Recommended Practices), 3) Design and Implementation of the Futurebus+ model, 4) Data Runs, 5) Analysis of Results, and 6) Present results/make recommendations to the customer.

Phase 1 began with the definition of the topology of the bus to be modeled. The architecture to be modeled was defined as a communications bus with 8 processors logically daisy-chained together. After obtaining the topology of the architecture, the performance characteristics of each processor were defined. Each processor was to operate at a different data rate. Data was to be transferred between nodes in packets and packet size to be varied for each node. The total available bandwidth was 800 Mbps given the specified data rates. The arbitration scheme to be used was distributed arbitration.

Distributed arbitration takes place in six (6) phases or steps. Step 0 is the Idle phase during which the first indication that a competition is beginning takes place. The Decision Phase is Step 1. During this phase a processor must decide whether or not it wants to compete for bus tenure. The processor must assert the appropriate signal in order to compete. During Step 2 or the Competition Phase, each processor monitors its own internal win signal to determine if it is the winner of the arbitration. The arbitration process is a priority based scheme with the highest priority processor winning the competition. Upon winning the competition, the successful processor

becomes the master elect. Step 3 is the Error Check phase which is used to ensure that no errors occurred during the previous competition phase. During the Master Release phase or Step 4, bus tenure is released by the current master. In Step 5, bus tenure is transferred to the winning processor. The master elect assumes tenure of the bus. During Phase 1 of the project, the draft specifications were obtained to enable the commencement of Phase 2.

Phase 2 involved studying the draft specifications in order to develop a working knowledge of the Futurebus+ Protocol and to determine which of its features were required in the model to meet the defined goal of the project. During phase 2, it became quite apparent that the scope of the modeling effort was grossly underestimated. Having no experience with the family of standards, it was quite difficult to comprehend the protocol specification. Any underlying assumptions of the specification were transparent to the researcher. The process of reading and understanding the specifications was quite laborious and tedious. After developing a working knowledge of the specification, the design of the simulation was begun.

Phase 3 consisted of blending the definition of the architecture to be modeled and the logic defined in the Logical Layer specification (P896.1 Draft 8.1) into the OPNET™ computer model. The Futurebus+ model was designed by transferring the defined top layer topology into an OPNET Network model which consisted of a bus with 8 nodes or processors connected to the bus via bus taps. The end result of this step is depicted in Figure 1. Upon completion of the OPNET Network model, each node on the Network topology was defined with an OPNET Node model. Figure 2 provides an example of a Node Model for one of the processors.

Each of the Node Models contained an Ideal Packet Generator, which generated data at defined time intervals or data rates; a transmitter; a receiver; an address node, a first-in-first-out (FIFO) queue; and the distributed arbitration node. Upon completion of Node model definition, each component of the Node model was defined by an OPNET Process model. See Figure 3 for a sample Process Model. The Process model defines the actual performance of each of the nodes on the bus.

This is the point at which the logic contained in the Logical Layer protocol was converted to C code. This C code controlled the transition from one state to another in the Process Model. This process is depicted in Figure 4. These transitions are controlled by scheduled and invoked interrupts which are defined within each process/state via the C code.

During the design, several ambiguities in the standard were discovered. One example was the definition of the competition number classes. While designing the implementation of the logic flow of the power-up sequence, it was discovered that the transition from Power-up to Bus-Init or System_reset or Bus_Init was not clear. It was decided to continue the design assuming that the system had reached a steady state and had achieved power up. During this process, the IEEE Working Group for Futurebus+ was contacted. The discussion with one of the lead engineers in the working group revealed that the standard had been changed. The current draft was P896.1 Draft 8.2. A copy of the new draft standard was requested and received within a few days. Upon receipt of the new standard, a study was conducted to evaluate the impact on the design to date with the completion of any required changes. Upon completion of Phase 3, it was time to move on the debugging and testing phase of the project.

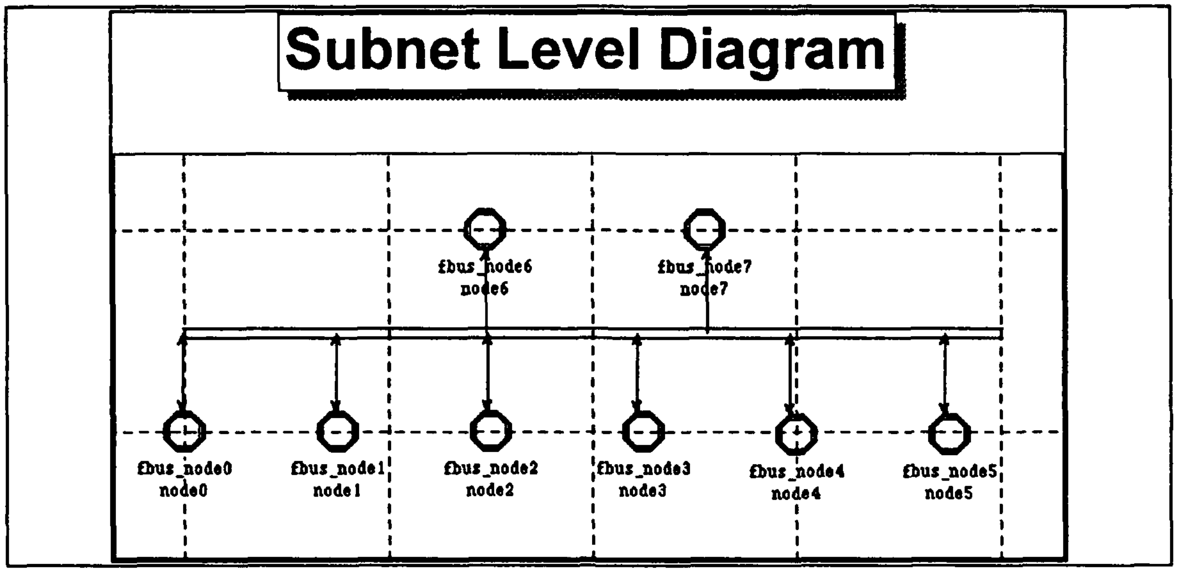


Figure 1

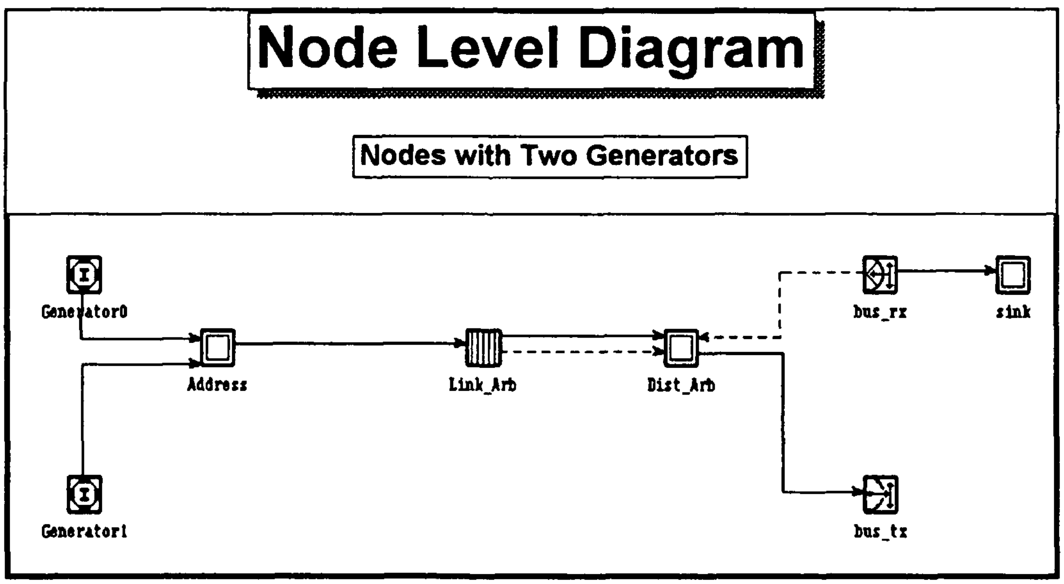


Figure 2

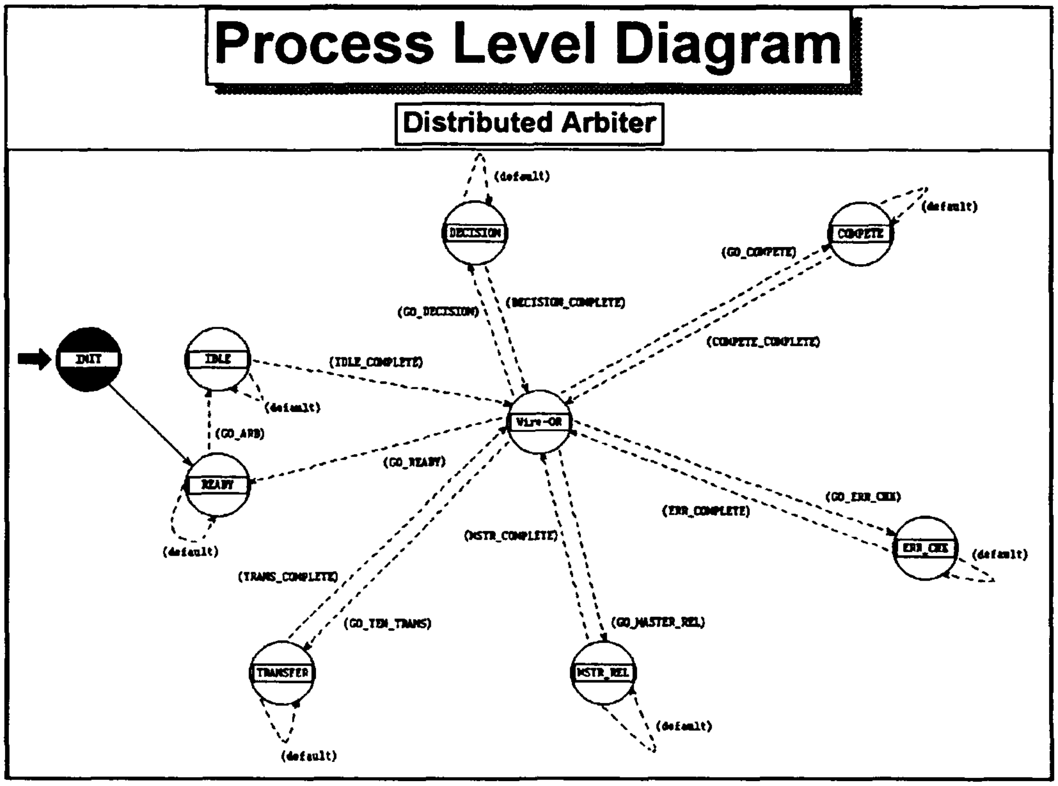


Figure 3

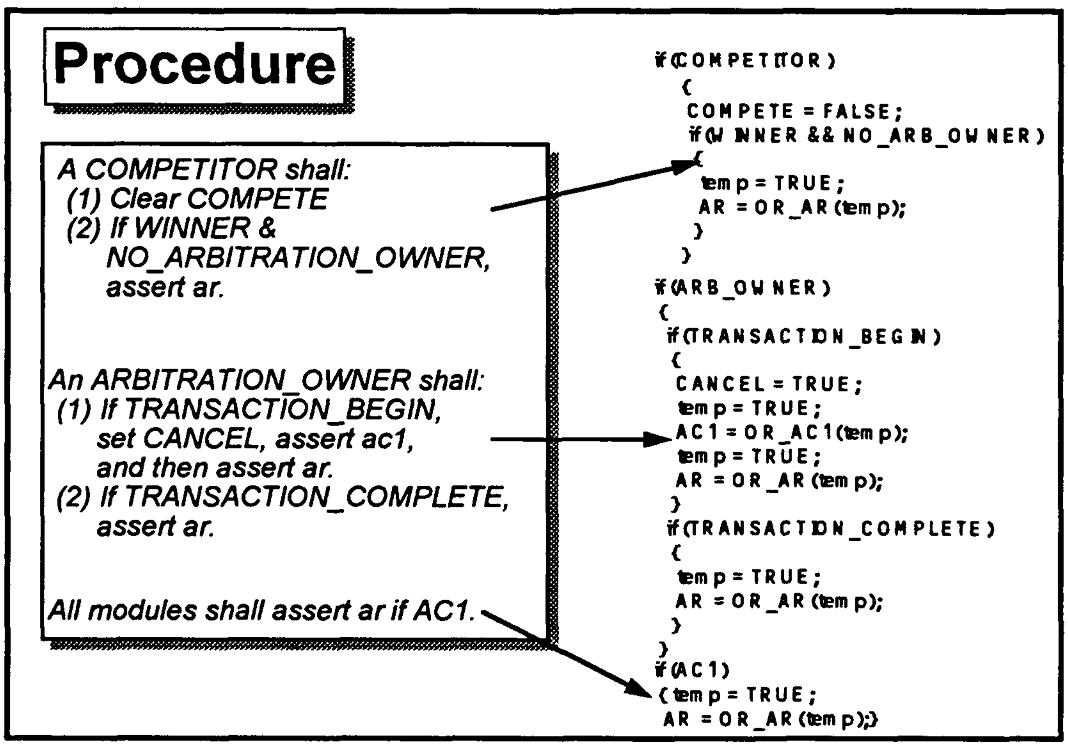


Figure 4

Phase 4 began with the definition of the measures of effectiveness to be used to analyze the results from the model. The measures of effectiveness used for the model were percent (%) bandwidth utilized, end-to-end delay time, mean delay time and throughput rates. The next step to accomplish was the definition of the data set to be used for the evaluation. The first data set defined the data rate constant at each node on the bus. The second case required the generation of random, uniformly distributed data rates for each node on the bus. Upon completion of the data runs, the results were analyzed.

The analysis of the results began with the computation of the theoretical maximum bandwidth utilized based on the defined architecture. This calculation was based on the constant data rates defined at each node, the size of the packets being sent by each node, and the bus speed. The theoretical maximum was computed including the overhead incurred due to the Futurebus+ protocol and with no overhead. With protocol overhead considered, the calculated percent bandwidth utilized was 2.68%. The measured bandwidth utilization from the model, which included protocol overhead and the constant data rates, was 2.6%. Upon implementation of the random data rates, the measured bandwidth utilized remained 2.6%. This indicated stability in the model. The measured end-to-end delay time was 2.6 microseconds, mean delay time was 430 nanoseconds and throughput was 20.7 Mbps. These results are demonstrated in Figure 5. Phase 5 ended with the conclusion that the goal of less than 10% bandwidth utilization could be achieved for the given architecture using Futurebus+ with Distributed Arbitration. Upon completion of the data analysis, Phase 6 began.

During Phase 6, the results were presented to the customer along with recommendations. As indicated above, the achievement of the desired goal was successful. Further evaluation was requested to determine at what point the bus would "break". The task was to determine the point at which the throughput was degraded. As a result, further test cases were run. These test cases were designed to incrementally increase the data rates and run the model with each set of parameters until the maximum throughput rate was achieved. A fixed priority scheme was used for the initial runs. These results appear in Figure 6. The end-to-end delay, mean delay, and throughput were monitored. The results indicated that throughput leveled off at 650 Mbps. Another data run was made using a random priority assignment and the leveling off point occurred at 650 Mbps.

Throughout the course of this evaluation, several lessons were learned. A brief discussion of some of these lessons follows.

LESSONS LEARNED

The lessons learned throughout this process were:

1. Importance of Futurebus+ Expertise
2. Interaction with Working Group Valuable
3. Required flexibility in model due to dynamically changing draft standard.

FUTUREBUS+ EXPERTISE

When this project first began, there was no engineering support available with a thorough understanding of Futurebus+. The process of learning about and understanding the specification would have been greatly

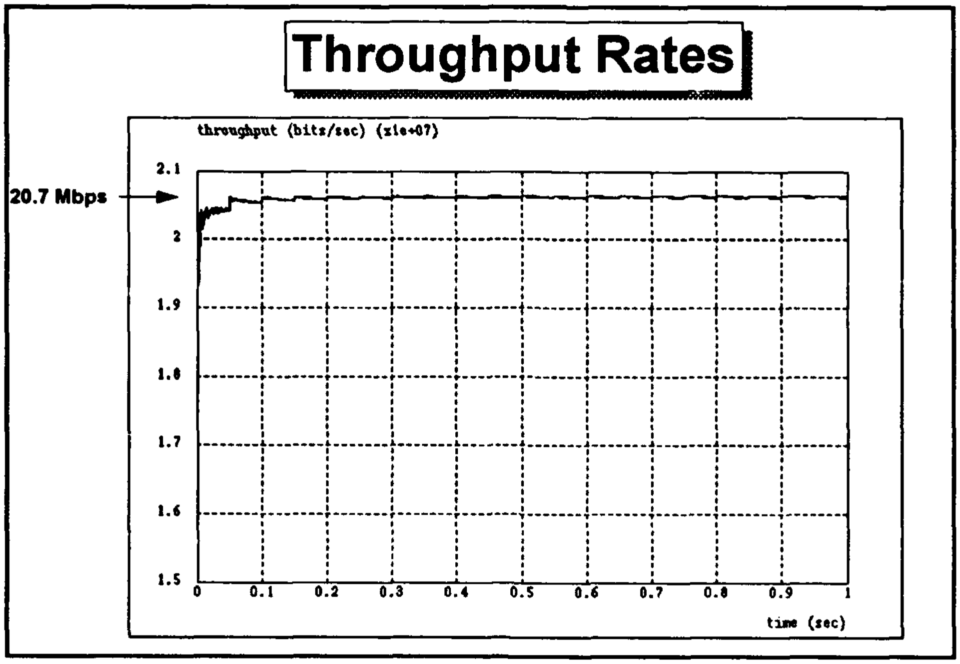


Figure 5

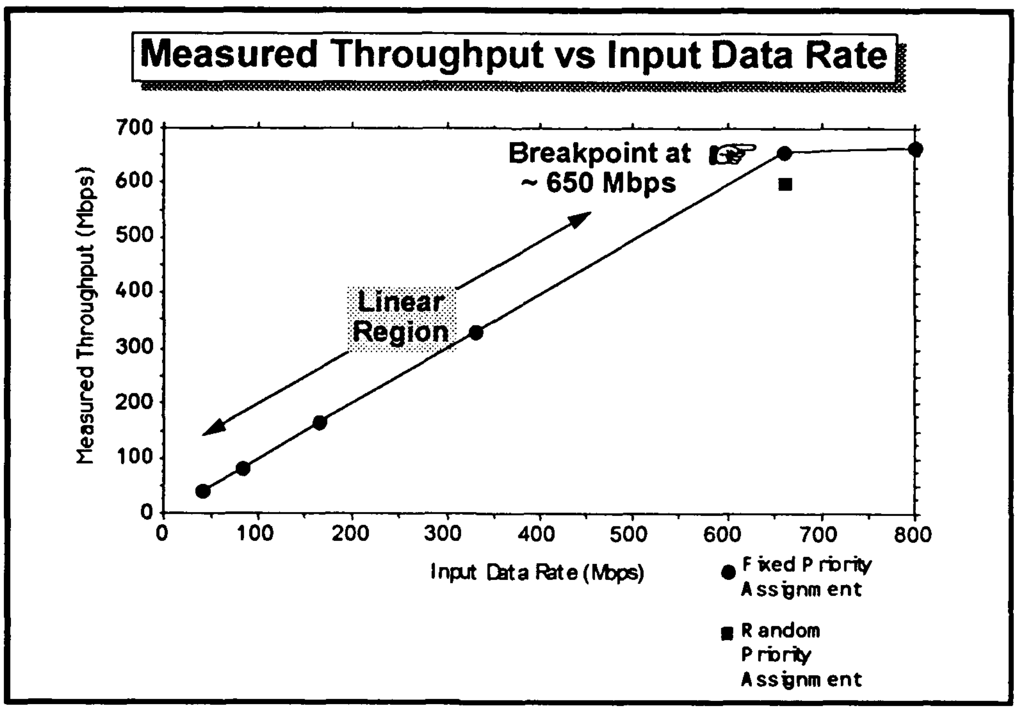


Figure 6

improved if an expert Futurebus+ engineer had been available to ask questions and discuss the intent behind some of the sections in the standard. At this time, the only Futurebus+ experts were those engineers involved in the writing of the specification and they were not available.

INTERACTION WITH WORKING GROUP

About eight (8) months into the project, we were asked to present our modeling efforts at one of the IEEE Futurebus+ Working Group sessions. The modeling project was presented to the Fault Tolerance group and the Modeling group. It was requested that we present a status report at the next working group meeting and we agreed to provide an update at that time. During the course of attending the working group meetings, a discussion with one of the key engineers on the Working Group revealed an underlying assumption which related the attribute definition and the protocol definition contained in the standard. This valuable insight into the Logical Layer specification would not have been possible without the engineering support gained at the Working Group session.

MODEL FLEXIBILITY

Another lesson learned throughout this project, was the importance of flexibility in the model when working with a draft standard. This became apparent when, early in the modeling process, several ambiguities were discovered in the specification. One inconsistency in the logic protocol was the way in which competition numbers were assigned to each processor. The IEEE Futurebus+ Working Group was contacted . When asked about the table contained in the logic protocol, it was determined that an outdated version of the draft specification was being used. An updated set of Futurebus+ specifications was obtained. The new draft standard was studied to evaluate the impact on the model. After determining changes needed in the model, the modifications were completed. Other discrepancies in the standard were discovered during the debug phase of the modeling effort and it was discovered that another version of the draft standard had been released. The new draft standard was obtained and studied to determine the impact on the model. Required changes were made and the debug process continued. This process took place several times. When the project began, the current standard was P896.1 Draft 8.3. The version which was approved was P896.1 Draft 8.5. Building the model with modularity and flexibility was extremely valuable during this phase of the project.

SUMMARY/CONCLUSIONS

While the modeling effort involved a very small portion of the family of Futurebus+ specifications, the usefulness of modeling and simulation in the development of a protocol standard was demonstrated. Even though many of the ambiguities and/or errors were corrected in the revised standards, the specification of the logic protocol in a formal language would enable the detection of errors and ambiguities quickly and would be cost effective. The engineers developing the standard could work hand in hand with the software engineers to insure proper implementation of the logic. Working together these engineers would form a team to evaluate the current design and study possible improvements.

The usefulness of modeling and simulation was also demonstrated in the testing of a proposed bus architecture built

on a specified logic protocol. The use of hardware was not possible as none existed at the time this project initially started. Modeling and simulation could be used to test the performance of the bus architecture using any number of communication protocols. These results could be compared to determine the best choice for the task at hand.

The field of modeling and simulation has indeed changed over the last few years. Its recent growth has enabled groups of all types to use it in new and interesting ways. One of those ways was the innovative use of simulations to evaluate the suitability of a communications protocol to a specified Communications Bus architecture.

BIBLIOGRAPHY

1. "Futurebus+ Logical Layer Specifications (P896.1 Draft 8.5)", Institute of Electrical and Electronics Engineers, Inc., 1991 [1]

EVOLUTIONARY ACQUISITION

of

Command and Control Systems

in Practice:

The Operations Support System

ABSTRACT

In the face of rapidly changing computer technology (hardware and software), the use of conventional approaches to command and control (C^2) system acquisition has often produced unsatisfactory results. Evolutionary Acquisition (EA) is an innovative acquisition strategy being utilized by the Space and Naval Warfare Systems Command's Command Systems Directorate to acquire software intensive, highly interactive C^{4I} systems.

This paper describes the implementation of the EA approach on one such system, the Operations Support System (OSS). OSS is a key element of the Navy Command and Control System (NCCS) which is being developed and implemented by the NCCS Program Office. This paper examines EA lessons learned by the Program Manager and the OSS Project Manager. It describes the character of EA as implemented and the organizational, political, and human aspects of acquiring a system using the EA strategy.

The decision to acquire OSS using EA has proved correct. However, there were, and are still, difficulties. The "Joint Logistics Commanders Guidance for the Use of an Evolutionary Acquisition (EA) Strategy in Acquiring Command and Control Systems" provided cautions designed to alert acquisition leaders to the necessity for "proper implementation" of EA. Two are quoted here: "Successful execution of an EA program requires a number of changed relationships and practices common to more conventional acquisition programs.... Establishing effective patterns of interaction with external organizations involved in an evolutionary acquisition can be expected to be unusually difficult, because the very nature of EA requires relationships and interactions different from the norm."

The EA concept is being successfully used to acquire the OSS by SPAWARSYSCOM.

INTRODUCTION

Evolutionary acquisition (EA) is a singularly effective approach to acquiring command and control systems. EA applies best to programs for which conventional acquisition strategies will lead to unsatisfactory results (e.g., the multi-year development and subsequent delivery of an already obsolete system because rapidly advancing technology outdistanced the original system requirements and specifications during the acquisition process). This makes EA particularly well suited for command, control, communications, computers and intelligence (C4I) systems, where technology, component performance and operational necessity are a continuously moving target. Other Navy C4I acquisitions have now transitioned from unique, turn-key developments to EA, in particular the Navy Tactical Command System Afloat (NTCS-A), the OBU Evolutionary Development (OED), and the ASW Operations Center (ASWOC) Upgrade programs. But there has been only one acquisition effort designed from its inception to invoke an EA strategy (EAS). This development, the OSS, has successfully broken new ground in its approach to systems acquisition, and, as directed in 1988 by the Assistant Secretary of the Navy, serves as the Navy's model for evolutionary acquisition strategy. The successes of this model Navy program have served as the impetus for other-service and joint program efforts to join the EA revolution.

EVOLUTIONARY ACQUISITION STRATEGY DEFINITION

EA was originally publicized in articles and studies in the 1980s and championed by BGen Edward Hirsch, USA (Ret.) of the Defense Systems Management College (DSMC). However, it is still modestly documented in the Department of Defense. DoD instruction 5000.2 states: "Alternative acquisition strategies should be considered for systems where requirements refinements are anticipated or where a technology risk or opportunity discourages immediate implementation of a required capability. Alternative acquisition strategies include evolutionary acquisition..... Evolutionary acquisition is an approach in which a core capability is fielded, and the system design has a modular structure and provisions for future upgrades and changes as requirements are refined. An evolutionary acquisition strategy is well suited to high technology and software intensive programs where requirements beyond a core capability can generally, but not specifically, be defined. This approach is described in Joint Logistics Commanders Guidance 'Evolutionary Acquisition, An Alternative Strategy for Acquiring Command and Control (C^2) Systems'."[1]

The JLC Guidance succinctly defines EA as "an acquisition strategy which may be used to procure a system expected to evolve during development within an approved architectural framework to achieve an overall system capability. Underlying factors in EA include:

- The need to field a well defined core capability quickly in response to a validated requirement, while planning through an incremental upgrade program to eventually enhance the system to provide the overall system capability.
- One or more increments (comprising the incremental upgrade program), which are treated as individual acquisitions. The increments' scope and content are the result of:

-continuous feedback from developing and independent testing agencies, the user (operating forces), and supporting organizations

-the desired application of new technology balanced against the constraints of time, requirements and cost.

As defined above, evolutionary acquisition comprises the following elements:

- A concise statement of operational concepts and requirements for the full system.
- A general description of the functional capability desired for the full system.
- A flexible, well planned overall architecture, to include process for change, which will allow the system to be designed and implemented in an incremental way.
- A plan for incremental achievement of the desired total capability.
- Early definition, funding, development, testing, fielding, supporting, and operational evaluation of an initial increment of operational capability.
- Sequential definition, funding, development, testing, fielding, supporting and operational evaluation of additional increments of operational capability.
- Continual dialog and feedback among users, developers, supporters and testers."[2]

OSS's EA BACKGROUND

OSS evolved in the mid 1980s from user discontent over the traditional approach to program development, in particular for FCC support systems. Fleet input eventually resulted in a Navy Warfare Requirements Board review and VCNO direction that a new program be initiated with an FY 90 start. Direction also provided for a new approach in acquiring this system. CNO promulgated an OSS Operational Requirement in December 1987. After many behind the scenes fact finding and operations requirements/needs discussions among CNO and fleet representatives, the OSS Project Manager, and ASN (RE&S), and finally a Program Review in September 1988, OSS was approved as an "Evolutionary Acquisition Strategy" (EAS) program by ASN (RE&S) 17 October 1988.

A caveat to this approval was the requirement that "an assessment of the planned OSS will be performed by an independent agent under ASN (RE&S) sponsorship prior to any final decision on release of OPN procurement authority". This study was conducted by a select committee of six experts in Navy command and control, OSS related technologies, systems development, and DoD acquisition processes. Noteworthy was the presence of BGen Hirsch among the committee members. The committee strongly supported the OSS acquisition strategy and recommended that ASN (RE&S) approve the proposed OSS approach. They added, ".... Candidly stated, the Assessment Study Group feels that: The Assistant Secretary of the Navy (Research, Engineering and Systems), as well as the Program Sponsor (OP-094), COMSPAWARSYSCOM and the Program Director must be active supporters of the Program Management team's efforts to implement successfully the EA approach to

acquiring the OSS. The above named leaders should cause their staffs to be favorably responsive to the program team's efforts to tailor the conventional acquisition process to accord with EA principles. Specifically, granting an exception to the logistics community to require a Logistics Review Group audit -- albeit "modified" -- appears to be a manifestation of a rigid mind set by our bureaucracy that can frustrate attempts by the management team to accomplish its mission".[3]

Following this recommendation (and prophetic advice), ASN RE&S completed the program approval process, reviewed the program again in an October 1989 Navy Program Decision Meeting (NPDM), and provided authority for the first two Increments of OSS to proceed. Funding for OSS as a separate, approved program began, on schedule, in FY 90. Establishing its precedent for quickly providing capability to the end user, OSS was in the process of its first operational hardware installation less than two months later.

OSS SYSTEM DESCRIPTION

OSS is an integral element of the Navy Command and Control System (NCCS) Ashore Program, a network of command and control components directly supporting commanders and their watch teams, including echelons from the Chief of Naval Operations (CNO) through the Fleet Command Centers. As a result of its wide acceptance, OSS has also been installed in the Unified Command Centers, NATO Command Centers, Foreign Navy Command Centers, MSC Headquarters, and will be the core of the PACOM Crisis Management System. Additionally, it is installed at SACLANT and CINCIBERLANT and is being considered for diverse NATO and other foreign command system developments. OSS is a critical component of the combined Command and Control thrust of the Navy Command Systems (NCS) consolidation effort currently ongoing in SPAWARSYCOM. This is essentially an effort to provide an optimal system of systems to support the afloat and ashore Navy C2 communities and their interfaces with joint and foreign systems.

OSS was initially planned as a means of replacing the functionality of three primary prototypes and one aging C2 system, but has evolved to include far more functionality. It is itself a system of systems, and employs extensive use of accepted government and commercial standards, and varying amounts of Commercial-off-the-Shelf (COTS) and Government-off-the-Shelf (GOTS) software. It also exploits the use of Non-Developmental Item (NDI) and COTS hardware to the maximum extent. Because of the rapid and progressive increases in NDI technology and performance at a low investment, OSS can optimize functionality and performance on a continuous basis. Savings also accrue through the lack of dependence on a long logistics trail. OSS is a distributed processing system, allowing software functions and components to be distributed among workstations and other computing resources to achieve optimum system performance within a given configuration. It employs a minimum core element to provide charting, tactical display and various housekeeping functions, and a modular structure for the rest of the system permitting addition, deletion and modification of functions as the need arises. Definition of inter-module interfaces is via Application Programmer Interfaces (API's).

Initial OSS workstation configurations consisted of Navy standard

Desktop Tactical Computers (DTC-2) based on the SUN Reduced Instruction Set Computer (RISC) architecture and the UNIX operating system. Current development employs the Hewlett-Packard TAC-3 Navy standard computers employing the HP OS also operating in a Unix environment. As a point of interest, the EA strategy allowed the fielding of the leading edge technology TAC-3 in a matter of weeks after contract award. This type response is nonexistent in traditional acquisition. Workstations communicate over a Local Area Network (LAN) using the Transmission Control Protocol/Internet Protocol (TCP/IP). Typical workstation functions can be economically achieved through devices such as X terminals or multiple remote monitors and keyboards off the powerful TAC-3. OSS extensively employs widely used standards including the emerging Common Operating Environment for Command and Control Systems, X-windows, Motif, UNIX, C, ADA, an IEEE 802.3 network with TCP/IP protocol, database access via SQL, extensive use of applications interface standards, and the Navy standard computers. Significant COTS products include Oracle, Motif, LMDS, Textract, and the Office Automation System, ASTER*X.

OSS functions are centered around an extensive capability to receive, process, display, and assess the readiness and disposition of own, neutral, and potentially hostile forces. Specifically, these functions include:

- An integrated database providing characteristics, performance and status of forces information, tactical data, and record messages with both automatic and user controlled updating

- Data retrieval through user tailorable forms, and automated query and report generation

- Tactical display utilizing track positional information, Multi-projection, Multi-resolution maps, Multi-source maps, predefined geographic areas, overlays to maps, tactical decision aids, and Near real-time update of positional data, and the ability to save, display, and print screens

- Fixed location database and display capability for ports, airfields and key assets

- Communications including AUTODIN connectivity, TTY, OTCIXS and Tactical Link

- Message handling and routing using extensive profiler and retrospective search capabilities

- Message Processing including creation validation (222 MTF Types), Input and Output message review, and message error correction

- Office Automation including Desktop Publishing, Spread-sheet, Graphics, Word Processing and E-mail

- Briefing support with Large Screen Displays, Video Switching, and various site selected monitors

Functions to be provided in near term releases include

- Joint Sorts information database and display

- Additional message format processing

- Improved message error correction capability

- Exercise database capability

- Employment scheduling integration

- Query Assist Language improvements

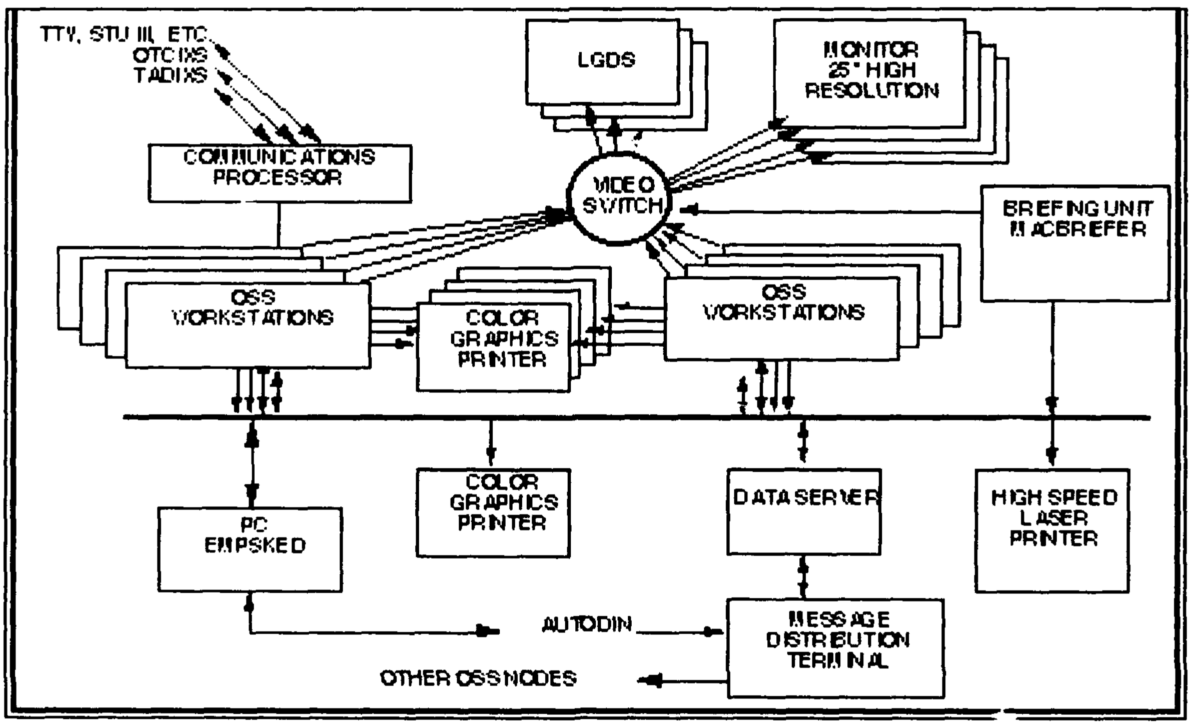
- Additional screen generation and tote boards capability

- Consolidated history file

- Enhanced Message handling capabilities

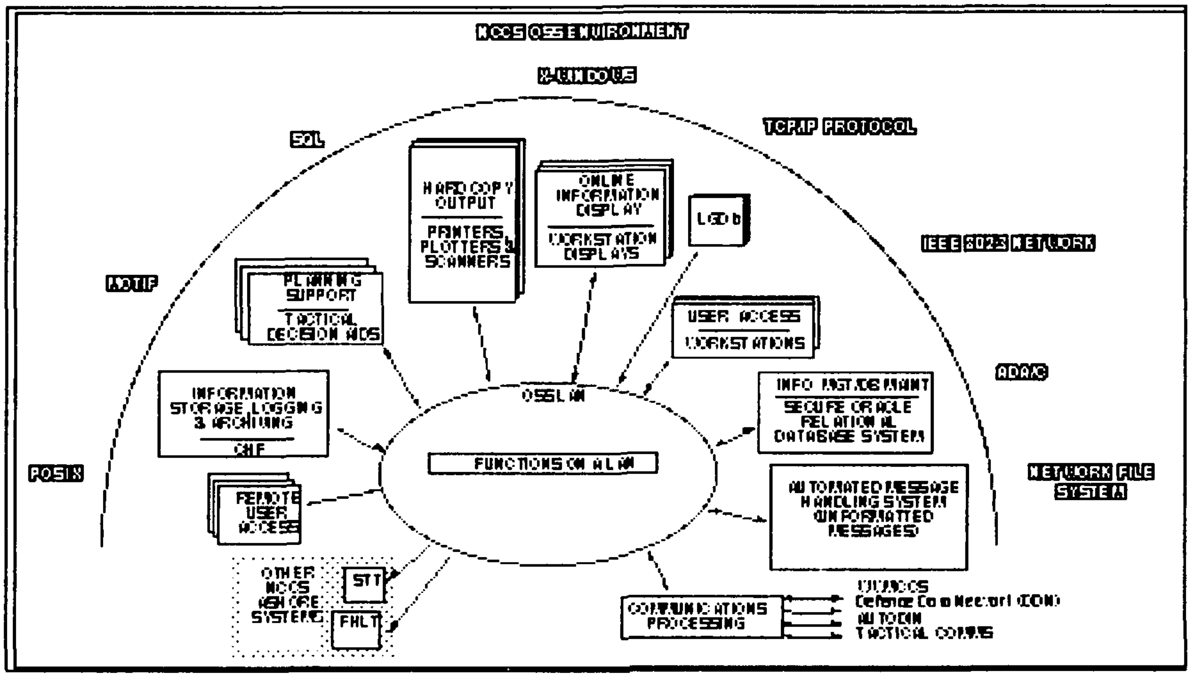
OSS is being developed in three increments, with the first providing capability by having systems working with each other over a Local Area Net. The second increment provides a system of functions operating over the net, with the third providing enhancements and increases in functionality to the second increment.

A typical OSS Increment I suite is shown below.



As the system matures, the individual systems will lose their identity in favor of performing as modular functions on a net.

The following diagram shows how OSS will look as a fully integrated system.....



This latter system concept fully embodies the EA approach. It creates the requisite framework wherein functions can be augmented or replaced with minimal impact on the rest of the system, and at minimal expense. It allows not only increased responsiveness in providing additional functionality based on technology and/or operational need, but also the capability to mix and match functions to meet the varying needs of different end users.

EVOLUTIONARY ACQUISITION IN PRACTICE..... IS IT WORKING?

Even with the apparent successes of OSS the question is often asked "is the EA concept working?" In short, the answer for OSS is an unqualified yes; it has worked extremely well. It has provided capability far beyond that envisioned in the planning for similar but monolithic developments in the mid 80's, at a fraction of the cost. It has also provided a proving ground for new and more efficient methods in procurement, such as implementation of Navy standard computers, establishment of standards which serve multi-service needs, and development of a common operating environment that will have world wide impact.

Of particular importance and success since the early stages of OSS was the development of the EA unique relationships with the user. Because this community's involvement initially assisted in the definition of OSS as an EA program, the relationship has progressed smoothly and quickly. The users are now an integral part

of the OSS team from the earliest stages of each development through the delivery, operational use, and maintenance of the system. This "team" concept is manifested in many user/developer dialogues, most significantly, the Fleet Project Team (FPT), Technical Working Group (TWG), and the NCCS Change Request (NCR) process.

The OSS FPT was established to enhance coordination among the sponsor, users, and developers of the system. It is convened at least semiannually to review the status of incremental developments with the users and to provide high level user feedback to OPNAV and SPAWARSYSCOM concerning system performance and supportability. In addition, the FPT provides the forum for identifying and prioritizing emergent requirements, and discussing development options. The FPT is chaired by the OSS Resource Sponsor and is comprised of Fleet and PMO representatives.

TWG meetings are also conducted at least semiannually, usually preceding FPT meetings. The purpose of the TWG meetings is to provide a technical forum to determine the status of incremental system developments, identify problems at user sites and to promulgate guidance to engineering activities and contractors. TWGs are chaired by the OSS Project Manager with participation from the Resource Sponsor's office, Project Management Organization (PMO), engineering activities, development, integration and support contractors, and users.

The NCR is the tool used to provide a common means for communicating information and priorities among the various participants in the OSS program. NCRs may be submitted by any OSS program participant to document a request for change, new requirements or problems encountered in OSS operation which require correction. NCRs are the primary tool in the change process and are the common ground for dialogue in the various OSS forums (e.g., FPT, TWG, CCB). Though often thought of as unglamorous, this is perhaps the most powerful and dynamic communication tool for ensuring the evolving system meets the end users' needs and is properly documented.

These forums and the day-to-day interaction between the Project Management team, the OSS users and developers have ensured that a team concept exists.

Another key area in the evolutionary acquisition of OSS is participation of the Commander, Operational Test and Evaluation Force (COMOPTEVFOR). OPTEVFOR is the key player in the testing of OSS. In EA, one of the changed relationships, and certainly one of the most important, is the relationship between the developer and the the test community, as epitomized by OPTEVFOR, the independent tester. The JLC Guidance says: "the independent tester is an important player in this process. It is imperative that he become involved early in the program development phase and maintain a direct and continuous liaison with the developer and user throughout the EA process, so that operational test and evaluation can proceed with maximum rapidity". The frequency of program incremental deliveries necessitates similarly rapid developmental and operational testing. This clearly demands a changed relationship with the operational test community (OPTEVFOR).

OPTEVFOR and the OSS Project Manager have successfully established this relationship. From the earliest stages of OSS development, OPTEVFOR has been involved. OPTEVFOR provides a representative to the FPT and the OSS

Configuration Control Board (CCB). Additionally, the OSS Project Manager requests OPTEVFOR representation at every test stage of development/acquisition, e.g., OPTEVFOR is requested to monitor developmental and integration testing at contractor and government sites in addition to their chartered responsibility to conduct operational testing.

Though SPAWARSYSCOM and OPTEVFOR have established a successful relationship, this area is also not without problem. The identification of test thresholds, the problem in identification of testable functions within the respective hardware and software releases, determination of what constitutes a testable release under an EA environment, and how/when functionality should be released to the fleet are sill undergoing definition. More definitive documented policy for EA and COTS/NDI efforts would be most helpful. There is an effort underway to do this. The arbitrary and artificial requirement to update the Test and Evaluation Master Plan (TEMP) for the sake of update when no major programmatic or functional change has taken place is not cost effective.

An integral component of user and test community involvement is the innovative and vital program of Beta testing (BT), which was established at user sites. Beta testing is an evolutionary test concept adopted by the OSS Program to involve command center users in the development effort ensuring system operability prior to each general release of OSS. One command center site is selected as the OSS "Beta Site" for each release following Developmental Testing (DT) in the lab. BT offers two primary advantages over Developmental Testing at a laboratory. First, an actual command center involves live message traffic and communications. Second, command center personnel offer a more realistic measure of system operability and suitability than test engineers. OPTEVFOR monitoring of Beta Testing at a live command center helps ensure that operational testing will be expedient and successful.

While more time and several test cycles and deliveries should be completed before a verdict regarding this aspect of OSS/EA implementation can be reached, it is clear that a powerful foundation has been established. It is also clear that this progress is chiefly a result of both the COMOPTEVFOR and OSS Project Manager's unbiased attempts to avoid inflexible mindsets in this critical area. Changes to directives, regulations and policies are required to institutionalize this process.

One of the significant remaining actions necessary to unlock the potential of Evolutionary Acquisition is the very one initially identified early in program development, and stressed during the Independent Assessment. That aspect which has not been streamlined is the programmatic and logistics review process, which have been somewhat inflexible and, in the extreme, not productive or cost effective. Most other reviews, documentation and development approaches have successfully been modified to meet an EA program's needs, resulting in a streamlined approach to the acquisition. But as warned during the independent assessment, the logistics review process has changed little. The programmatic time and manpower put into responding to program investigations of questionable value has resulted in potential development dollars going toward "bureaucratic" requirements. Findings of these audits have shown that the inflexibility of the directives, regulations and policy can

be detrimental to the evolution of a successful program. Unrealistic requirements to create supply lines that will take three years to put in place for hardware that will be in place only three years at the most, personnel requirements for unnecessary positions, and rigid waiver requirements for Commercial off the Shelf products for ashore systems that have no need to meet the same rigid standards as for afloat use are but a few examples of standard acquisition program requirements inflexibly forced on the OSS program. These requirements are not consistent with the concept of EA or the acquisition of C4I systems. Further, the resources allocated to meet these extraneous requirements are inevitably diverted from the acquisition of hardware and software. Until changes are made in the development oversight process, there will be a thorn in the side of Evolutionary Acquisition.

Additionally, the program review process has yet to completely come to grips with EA. When should a program be reviewed? What requires Navy Acquisition Executive approval? With frequent software releases, some combined with hardware upgrades, and numerous increments and phases, what constitutes Initial Operational Capability, Full Operational Capability, etc? These are but a few of the dilemmas routinely faced. Thus far, dedicated people with open minds have worked these issues for the OSS, but long term the documented process must be changed. As the acquisition work force down sizes and program funds are reduced, efficiency and streamlining are mandatory.

Regardless, and in spite of the problems with acquisition regulations and policy, OSS as an EA has worked extremely well and has been exceptionally successful. The many successes of OSS have proven the concept works:

- Rapid deployment of capability has been proven. The installation of the first OSS computers shortly after the program first started followed by frequent software releases providing increased functionality and tailoring and fine-tuning of existing functions has demonstrated this.

- Capability to meet fleet requirements on a set, realistic and frugal budget has been proven. Significant capability has been provided at a fraction of the cost of that initially envisioned for other late 80's system developments of this magnitude.

- It has adequately demonstrated that a program can be flexible enough to bend with a changing budget environment without toppling the system development or ending in significant system delivery delays. Decreases in budget are met with a reduction in delivered functionality, rather than a significant delay in the total system delivery. Increases in budget provide the bonus of additional functionality or systems upgrades that can generally be realized in the same budget year

- It has proven that with EA, a build a little, test a little, field a little approach will provide a reliable and extremely capable system to the end user. It also allows fixes and tailoring to be done in parallel with the development of new functionality.

- The development approach has shown that creation of and reliance on mandatory standards for software development, hardware and interfaces is invaluable to EA. These standards are the keystone on which all developments and future changes and enhancements can evolve. Development of a formally defined common operating environment

was also key to ensuring other systems and components developed in parallel are compatible and has afforded the leveraging of other investments and the synergy of effort.

As the OSS system matures, it has and will provide a wealth of knowledge based on first hand experience in evolutionary development. Even with the successes, the concept and the program are not without fault. The overall development is subject to the personalities of the Sponsor, the Project Manager, the System Integrator/Engineer and Developers, and the Users. Time will be the judge of the success of the OSS program strategy. It was created by its initiators in the belief that the concept could work. These pioneers of the EA strategy carved a plan which was responsive to the user, met their requirements, was reliable and quickly fielded, and which could exist in a rapidly changing funding environment. Full program management commitment and dedication to the concept from the top down combined with further streamlining of the acquisition process will ensure the EA development concept will continue to succeed.

The EA strategy for OSS has achieved these success in spite of a natural resistance to change. This resistance to change is still problematic. Testing philosophies developed for monolithic developments must become more flexible and dynamic, with redefinition of test phases, operational and baseline capabilities and thresholds to support EA. The Logistics Review process must be modified to accept EA, and permit alternative concepts of logistics support. The DOD acquisition process must more completely endorse EA as an efficient way of doing business, and provide requisite documentation to support and allow a flexible approach to program development where that approach is appropriate. These changes would all improve this already efficient method of Defense Acquisition.

CONCLUSIONS/SUMMARY

Acquisition of OSS using an Evolutionary Acquisition Strategy is being successfully implemented. Despite rigid mindsets by well meaning officials in the acquisition and logistics communities and some unnecessary, inefficient resource allocation to standard acquisition program requirements, most obstacles have been overcome. Most encouraging have been the successes OSS has achieved in providing rapid deployment of state of the art technology to meet fleet requirements. This has been achieved chiefly through (1) the open minded participation of the user and test communities, (2) the innovative, patient, persistent, and bold leadership of the OSS Project Manager, and (3) the support of the Program Manager, Program Director, Program/Resource Sponsor, in particular, VADM Jerry Tuttle (N6), and the N62 team, and ASN (RDA).

Evolutionary Acquistion is <u>the</u> most effective approach to acquiring C4I systems and is being successfully impleemnted by SPAWARSYSCOM to acquire systems such as the Operations Support System.

BIBLIOGRAPHY

1. Department of Defense (DOD) Directive 5000.2, February 23, 1991, part 5, Section A, *Acquisition Strategy*, page 5-A-1.

2. U.S. Department of Defense, Defense Systems Management College, *Evolutionary Acquisition, An Alternative Strategy For Acquiring Command and Control (C2) Systems, Joint Logistics Commanders' Guidance*, ([Fort Belvoir, Virginia]: Defense Systems Management College, March 1987, page 3.

3. "Report on the Independent Assessment of the Operations Support System", 17 February 1989, Study Group Chairman Mr. Robert Hillyer, for the Assistant Secretary of the Navy (Research, Engineering and Systems), page A-1.

The source for portions of the history/background, system description, and opinion on the success of evolutionary acquisition in this paper is " A White Paper on OSS Evolutionary Acquisition" by Robert W. Welty.

Title information on the authors:

Captain F. A. Holk, Jr
Space and Naval Warfare Systems Command
Arlington, VA

Debra Martin
Space and Naval Warfare Systems Command
Arlington, VA

Robert W. Welty
SAIC
McLean, VA

John T. Wells
PRC, Inc
McLean, VA

VIRTUAL PROTOTYPING - Concept to Production

Colonel Nelson P. Johnson
Lieutenant Colonel Albert B. Garcia
Lieutenant Colonel Robert P. Gocke
1992-93 DSMC Military Research Fellows

ABSTRACT

Computer technology has reached a level of maturity where virtual prototyping can be a major benefit to the DOD acquisition process. Virtual prototyping is a computer based simulation with a degree of functional realism comparable to a physical prototype. Used for concept definition, idea exchange with users, product design, test and evaluation and as a decision tool, virtual prototyping is applicable to both major and less than major systems and their components.

Virtual prototyping is an automated method that can maximize the benefits of integrated product teams through the use of scientific data visualization, 3-dimensional drawings and animated simulations. It facilitates rapid multi-discipline communication, which translates to more robust designs, lower design and manufacturing costs and compressed cycle time. Virtual prototyping facilitates the DOD Dual Use thrust because of its electrical transportability, the reuse of designs and the ability to rapidly reconfigure system characteristics throughout the engineering design process.

The fidelity of existing 3-dimentional virtual prototyping systems has reached the level of confidence where major defense contractors are foregoing physical mockups. Virtual prototyping is seen as one of the best ways to reduce costs and gaining an essential competitive advantage in the 21st Century.

Our review of existing DOD acquisition policies indicates there is flexibility to accommodate virtual prototyping principles, but to date it appears that few program managers have taken advantage of this value-added process. How to maximize the use of virtual prototyping in DOD warrants further investigation. Virtual prototyping has the potential for providing DOD decision makers the ability to select optimum weapon systems based on their impact in an electronic battlefield simulation - the "marketplace" of the future.

Integrating Innovative Entrepreneurship, Optimal Privatization and Total Quality Management into our Defense Acquisition System

Van R. Johnston and Robert J. D'Amico
United States Air Force Academy

ABSTRACT

The Department of Defense acquisition process needs re-evaluation and re-adjustment. The need for this adjustment centers around tremendous change and competition in the world marketplace. These dynamic forces require that we seriously rethink how we acquire new weapon systems. In this paper we analyze changes in the defense acquisition environment and make suggestions for improvement. The changes we focus on include the acquisition process itself, optimizing privatization and competition efforts, innovative entrepreneurial approaches to defense acquisitions, and Total Quality Management in the defense acquisition arena. Finally, we preview national security and defense positions sponsored by the new Democratic Administration.

THE NEED TO REEVALUATE AND REALIGN DEFENSE ACQUISITIONS

With the transformational changes occurring internationally and in the United States, it becomes imperative that we research, innovatively redesign, and implement new defense acquisition strategies in order to be able to optimize both private and public sector contributions to our national defense system. Abroad we find significant contributions, like those of Japan to our high technology weapon systems.(1) The Soviet Union has crumbled, leaving questions, even after START II, regarding the control and disposition of significant weapon systems left over from the former USSR. The Warsaw Pact has vanished, ostensibly requiring less commitment on the part of the United States for support of its NATO allies. The Gulf War, manifested primarily by Operation Desert Shield and Desert Storm, proved beyond a doubt that current U.S. weapon systems are both advanced and lethal in terms of efficiency and effectiveness when compared to other systems in the world. This conflict also demonstrated that U.S. military forces are exceptionally skilled in their profession. In 1992, the European Common Market began to cause concern about increasing competition from Europe, while the North American Free Trade Agreement forced us into different modes of competition in North America.

Competition has become one of the primary themes of the decade. Increased efficiency and effectiveness have permitted both private and public sector managers to do more with less. Change is occurring at all levels of both the private and public sectors.(2 & 3) Traditional blue chip corporations such as General Motors and IBM have cut back substantially on facilities and payroll.(4 & 5) The U.S. military is reorganizing and downsizing approximately 30% in just a few years, and the defense industry as we have known it is being transformed.(6) Employment is projected to plummet by 300,000 in 1993.(7) There have been numerous studies of, recommendations for, and adjustments towards more competition within the DoD and the military acquisition system.(8) A significant portion of the contraction in defense will come from procurement by way of defense contract reductions. The recent radical downsizing is exacerbated by a cyclical downturn and by continued procurement reforms.(9) Yet, while the Pentagon, the White House, and Congress all relied on competition to solve the fraud, waste and efficiency problems in the procurement system, we now find that

perhaps the major change was a drop in contractor profits, while fraud and waste can still be found.(10)

Such are the forces that come into play when analyzing how to adjust the military acquisition system towards more optimal performance in a turbulently dynamic and changing world. Both internationally and domestically, we are witnessing nothing short of a "paradigm shift."(11) In order for us to be able to support the transformed defense mission in this country, we will have to completely re-evaluate the world of defense and military acquisitions, and re-align and re-design it so it can be synchronized with the new world we will find as we approach the mid-1990s. In particular, in this manuscript we will explore developments unfolding in defense acquisition, privatization, and competition, innovative entrepreneurship and Total Quality Management. We will then extract lessons for adjusting the defense acquisition system so that it can work more optimally in the new world we find emerging in mid- 1990s.

CHANGES IN DEFENSE ACQUISITIONS

Current changes in the defense acquisition world are rapid and dynamic. These changes are occurring on many fronts ranging from privatization and entrepreneurship to TQM. The impact of these changes is significantly affecting the defense acquisition process.

Maintain The Industrial Base

Future weapon systems acquisitions will certainly change. Downsizing caused by diminished enemy threats, fiscal resource constraints, increased operational life of major weapon systems, and escalating costs of new systems are all major factors influencing the defense acquisition system of the future.(12) The "pipeline" procurement process is changing and being replaced with several new and innovative approaches to defense acquisitions.(13) The underlying theme in these new approaches is an attempt to maintain the defense industrial base.(14) The DoD has four main objectives for maintaining the industrial base:

1. It must support the basic peacetime force structure level.

2. During wartime, it must be able to provide weapons during times of crisis.

3. It must provide rapid production capacity to meet a global threat.

4. It must be efficient and cost effective.(15)

The new Secretary of Defense, Les Aspin, former Democratic Chairman of the House Armed Services Committee, has proposed some measures to maintain this industrial base despite turbulent changes affecting this industry. His plan includes selectively upgrading weapon systems and selectively procuring new weapon systems at a low production rate in order to keep critical defense suppliers in business. Additionally, the new Secretary intends to prioritize "silver bullet" procurements high on the acquisition procurement priority list. These "silver bullet" procurements will include technologically superior weapons systems that will act as force multipliers during conflicts.(16)

Another major aspect of Aspin's plan to maintain the industrial base revolves around research and development. This aspect is called "Rollover Plus." It encompasses multiple research and development cycles leap frogging technological progress over technological generations without having multiple production programs. The "plus" refers to upgrading manufacturing technology, operations testing, and concurrent engineering programs.(17) The drawback with the "rollover plus" concept is that no strong financial incentives currently exist to encourage defense manufacturers to concentrate on research and development

while omitting or significantly cutting back on the production cycles. Typically, the production line provides defense manufacturers with their profit incentive.(18)

Flexible Acquisition Strategy

The new defense acquisition strategy includes many new ways to make DoD procurements. However, none of them embrace the long-standing tradition of the "pipeline" procurement process. Instead, new procurements embody flexibility and adaptability. This new flexible acquisition strategy will still use military oriented research and development, but the DoD will also use commercial technologies when possible. Additionally, some acquisition proponents endorse using "shelved technology" where a weapon system is developed through the prototype phase, including working out the defects, and then is stored until it is needed. Only if the product is needed does it ever enter the production pipeline. Multiple research and development cycles will also be used to keep us technologically ahead of any enemy without incurring the production costs. Instead, our defense industry will be working on new generations of technologies from prototypes of older generation technology that are still significantly more advanced than those of our enemies.

The true goal of this new, flexible acquisition strategy is to assemble and deploy new weapon systems during mobilization and build-up of our forces during a conflict. This just-in-time inventory methodology can be an extremely effective and efficient method for weapon acquisitions.(19) However, it is dependent on the ability of defense manufacturers to get new weapon systems through the production line in a timely way. Many analysts, however, believe that the manufacturing technology of our defense industry is not up to this challenge. For example, a Rand Corporation study identified several weaknesses in the defense manufacturing industry. These analysts cited the need for improved production and plant operations to include computer aided manufacturing. This upgraded manufacturing technology could increase production flexibility and help the defense firms reach their profitability goals even with reduced procurements by having high production efficiencies despite low production quantities.(20)

The DoD's new defense acquisition strategy embodies most of the above mentioned ideas. Their new strategy is designed to ensure critical manufacturing capabilities will be maintained despite a reduction in procurements. Adequate production capacity would remain a priority. The DoD still plans to maintain production lines with significant spending levels through the decade. Spending on new weapon systems, however, will be made very judiciously using the following criteria:

1. The technologies have been demonstrated, tested, and proven to be manufacturable.

2. There clearly is a military need for the new system.

3. The new system is cost effective.

Systems that meet these criteria will go beyond the research and development level and enter into the production phase of acquisitions.(21) Although the quantity of new weapons produced will decrease, new key technologies referred to as "silver bullets" by the defense establishment, will be redesigned to maintain our technological advantages. They will drive DoD efforts to develop and produce new and innovative technology.

The new DoD acquisition strategy is designed to promote flexibility and selectively procure new weapon systems to maintain our technological edge over our enemies, while still maintaining our industrial base. One method to help downscale the size of the military acquisition process is to privatize as many functions in the acquisition process as possible.

As the combination of increasing competition, cutbacks, and reorganization have begun to take effect, alternatives have been sought for the traditional acquisition service delivery and support systems. One of the most promising alternatives has been fine tuning privatization. By creating competition between maintenance depots and private firms, DoD is optimizing efficiency during this period of downsizing and shrinking budgetary support. The goal has evolved toward providing the best service for the best price. The most significant change has been to privatize some of the maintenance functions of newly acquired defense hardware. It is also important to set up and monitor competition between private contractors and government employees so that it is possible to determine equitable cost comparisons. At the same time DoD must guard its ability to provide the appropriate surge capability. The effect of the adjustment has been to improve overall performance by monitoring and adjusting support costs and by consolidating operations. Additional privatization options include system repair work and related DoD contract work. Many peripheral duties involved in acquisitions can also be privatized. These peripheral duties could include security personnel, legal staffing, contract administration support, and supervision of contracts. Beyond these adjustments, the DoD is moving towards private sector products and processes where possible. This shift from militarily unique products and services will both increase military access to the national industrial base and support the growing trend towards privatization of public sector services, both in this country(22) and abroad(23) as the political, military, and industrial world changes.

Purchasing weapon systems and equipment represents the largest category of public sector purchases from the private sector. The contracts with private firms for hardware, research, and logistical support are an integral part of our modern defense structure. One third of the 1987 defense expenditures of $295 billion was spent on DoD personnel. The remaining $186 billion went for goods and services purchased from the private sector. Most was spent on procurement of goods like hand tools, office supplies, cars, and many other commercially produced goods. However, private sector services that are significant included transportation, research and development, base management, and administrative support. The money spent here was more than the total payroll for all of our uniformed personnel in the armed services ar ' over twice the payroll for civil service defense employees.(24)

The system, because of its size and impact, draws a lot of attention and criticism. Typical complaints over time include the following:

1. The system delivers too little for the amount of money paid and accountability is not adequately enforced.

2. The system often builds weapons for the wrong wars, has continuous development and production delays, and has significant and recurring quality problems.

3. Accountability is seriously lacking. Criticism is most notably focused on costs, schedules and standards.(25)

There is also a perception, among the public, that private contractors, the military, and politicians working together often ignore the public interest and make mutually beneficial agreements that do not optimize military needs. Such coalitions are referred to in academia as "iron triangles." While some would argue that it is virtually impossible to reform the system, there have been numerous congressional findings and military reports (26) over the last decade calling for increased competition to solve the problem.(27) There have also been hundreds of legislative proposals for procurement reform. And the mid-1980s

witnessed landmark legislation such as: the Competition in Contracting Act, Warranty Requirements in Appropriations Bills, contractor cost limitations, and reduced allowable profit margins.

Many would argue that the subsequent increased competition has solved a major part of the problem. Others point to the increased costs and other tradeoffs, like time, involved in establishing more competitive systems. The reality of the very limited number of prime defense contractors and the enormous amount of money to be invested at competitive bids is a factor to be dealt with.(28) Since, in 1993, we can see a reduction of 300,000 private defense industry employees, the prospects for increasing and maintaining meaningful competition becomes even more challenging.(29) Approximately 60% of defense contracts were awarded competitively in 1987. In 1983 it was about 33%. The defense industry, in a study of its own warned that if contract guidelines were tightened too much, the effect would be to force more companies out of competition thereby limiting competition in the future.(30) Lundquist argues that profitability was destroyed by the reforms of the 1980s and by coupling the building and research and development phases. Fixed price contracts cost taxpayers too much and the industry, also reacting to the downsizing forces, will experience a serious shake-out with the survivors being those defense companies which are the smartest in their downsizing strategies.(31)

One area ripe for rethinking is how private or how public the acquisition system either needs or ought to be. It may be that upon analysis under the currently changing world situation, that a realignment of the system from its research and development functions right through to production and beyond to maintenance, is in order. There is a history of significant public sector involvement in this arena.(32) Perhaps the balance between private sector and public sector functions can or should be adjusted, given the transformed national security environment we find in 1993. Should we end up with fewer viable defense companies to provide meaningful competition after the shake-out, a re-evaluation and re-alignment of the private-public sector balance would be in order.

Even the pro-military Bush Administration acknowledged that private contractors waste billions of dollars due to mismanagement. There were also calls for increasing resources for hiring more federal auditors.(33) Given such a state of affairs it should be apparent that management on both sides of the issue should take a long hard look, especially with all the changes being experienced in the transformation of defense in America and the rest of the world.

One recent policy development worthy of note is progressing in the direction of increased accountability regarding private sector contractors. The Single Audit Act, implemented in 1984, (34) was designed to improve the management of federal fiscal resources in state and local governments. Concurrently, private CPA firms were contracted to assist in this function. The 1984 Act was applied to monitor the auditing function. Recently, it has become apparent that the 1984 Act has been extended to audits of businesses contracting with the government as well.(35) This is an evolutionary step which could provide a significant mechanism to monitor privatization efforts in the defense acquisition system in the future.

INNOVATIVE ENTREPRENEURIAL CONTRIBUTIONS

With the promise of transformation of the national security arena and our defense establishment, we will need to make significant adjustments in our acquisition system if we are to optimize innovation, creativity and responsibility. It has been about fifteen years since the voters launched the taxpayer revolt with

California's Proposition 13 on June 6, 1978. Having local property taxes cut in half, then watching the conservative approach to government from the Reagan Administration and the recession of 1982, government managers and administrators had no choice but to redesign their approach to responsibly deliver their services.(36) In November 1992, Colorado passed a similar measure, known as Amendment 1, (37) indicating that the revolt is still underway. Americans want, and are demanding more quality services for less money, and private sector concepts of quality, efficiency and entrepreneurship are becoming increasingly important.(38)

Fewer services or higher taxes are among the obvious answers. But Americans are demanding more. And, as public managers have begun to recover from the fiscal and service demand assaults, their innovative adjustments have begun to take root demonstrating improvements in both quality and quantity. The emerging paradigm, however, is very different than the lethargic and unresponsive bureaucracies have offered in the past. The new paradigm could be described as decentralized, flexible, adaptive, competitive, learning, customer oriented, creative, lean, and streamlined.(39)

Forced to change the way they went about the business of government, public managers developed a new model of government. It included both managerial and governance concepts that would permit them to cover the legal mandates while innovatively and at times aggressively, attacking traditional bureaucracy as they launch into a new era of delivering government services. New approaches and concepts such as contracting out, privatization, (40) public-private partnerships, load shedding, alternative service delivery, participatory management, empowerment, and total quality management were tried and accepted as they proved useful. As we move well into the mid-nineties, there is an increasingly large list of successful experiments at all levels of government. Some are identifying the change as a paradigm crisis in the classical Thomas Kuhn paradigm shift sense.(41)

As President Clinton takes over as the leader of the national government in 1993 we already have some clues as to how he intends to approach delivering government services and products to more people at higher quality while attempting to reduce the deficit. He has already endorsed a host of cutting edge concepts, instruments and approaches delineated in a book by David Osborne and Ted Gaebler titled <u>Re-Inventing Government: How the Entrepreneurial Spirit is transforming Government</u>.(42) On the cover of the book Clinton is quoted: "This book should be read by every elected official in America. Those of us who want to revitalize government in the 1990s are going to have to reinvent it. This book gives us a blueprint." Senator Sam Nunn also has an endorsement on the cover. A <u>Time</u> article, after the election, entitled "A Prophet of Innovation" describes author David Osborne as one of Clinton's people...to be consulted on how to reinvent government and fight bureaucratic bloat.(43) Endorsements such as these, made by policy makers who will have an important impact on defense acquisitions, are worthy of note.

Osborne and Gaebler present numerous military and non-military examples of doing more, innovatively and creatively, with increasingly fewer resources. In brief, they set forth ten principles, reconstructed as follows:

1. Alternatives to in-house service delivery should be explored to find more efficient alternatives. Vouchers, contracting out, volunteers, and public-private partnerships are just a few ideas here.
2. Competition should become a greater factor wherever it can be effectively infused.
3. Management teams and governing councils can and should be empowered to take on many program responsibilities.

4. Rules should be dramatically reduced. Budgets should be re-designed and program management streamlined.

5. Performance measurement should be re-thought and oriented towards performance and policy outcomes as opposed to program inputs.

6. Governments can and should earn money via fees, internally competitive profit centers, and shared savings, etc.

7. Governments should set up market systems where appropriate.

8. Clients are customers. Survey them. Find out what they need and want. Train employees to serve customers. Aim towards service qualities and conveniences.

9. Decentralization through teamwork, participatory management, quality circles, employee development programs, and labor management efforts should be optimized.

10. Prevention should become a priority. Assertively forestalling maintenance, health, and trash problems in advance would be appropriate examples.(44)

Osborne and Gaebler are clearly at the cutting edge of entrepreneurial management in the context of delivering the services and goods of government efficiently and effectively. Many of their proposals would not be appropriate for acquisitions. A great number of them would be, however. There are some professionals who address the governance caveats involved in such adjustments as well. Johnston has examined many of the trade-offs in privatizing government management and has raised some of the sovereignty and governance concerns as well.(45) And, in a review of the Osborne and Gaebler book, Charles T. Goodsell offers "Goodsell's Ten Principles of Rediscovering Government."(46)

TQM IN THE NEW DEFENSE STRATEGY

The U.S. military is embracing the concepts of Total Quality Management with open arms. With a strong customer focus, continuous process improvement, and genuine concern for people quality management improvements should have a firm foundation in the acquisition process. Quality management driven improvements can help the DoD towards its goal of an efficient and cost effective industrial base with high efficiencies despite low production levels.

In July, 1992 the U.S. Air Force completed a major reorganization designed to improve efficiency and improve customer satisfaction within their acquisition system. Before this reorganization the acquisition process, from Milestone 0 through Milestone 3 and part of Milestone 4, was controlled by the Air Force "Acquisition Specialists" in Air Force Systems Command (AFSC). Typically, once the new weapon system made it past full scale production and into the operations and support phases of the acquisition process, transfer of responsibility for acquiring and maintaining that weapon system was made to the "Maintaining and Supply Specialists" in Air Force Logistics Command (AFLC). This transfer of responsibility caused a lot of frustration for manufacturers, users, and maintainers of these new weapon systems because there was no single point of contact for weapon systems questions and problems.

Because of the inherent inefficiencies of having two different commands managing a weapon system, depending on the weapon system life cycle stage, the Air Force combined these two organizations into a newly formed command called Air Force Materiel Command (AFMC). AFMC is a large Air Force command with 125,000 people and 50% of the Air Force budget.(47) AFMC's mission is:

"Through integrated management of research, development, test, acquisition and support, AFMC advances and uses technology to acquire and sustain systems in partnership with the customers."(48)

The merging of AFLC and AFSC was completed on July 1, 1992. This new organization procuring new weapons systems for the Air Force has integrated several acquisition process areas into a new management approach called "Integrated Weapons System Management."(49) This new focus of integrating procurement, supply, and maintenance of weapon systems, all under the control of one director, has helped increase responsibility among acquisition personnel who manage an entire program over it's entire life, rather than shifting responsibility for program management to some other organization part-way through the weapon system life cycle. The Integrated Weapons System Management Program has three components:

1. "Cradle to grave" management of weapon systems so that acquisition personnel consider the entire product life cycle in decisions.

2. Provide customers with one focal point, one source of information and decisions in the Air Force.

3. Create a seamless organization responsible for eight critical processes ranging from managing funding for a new weapon system to upgrades for it.(50)

Total Quality Management ideas have been incorporated into the restructure of AFSC and AFLC. This approach to quality improvement was used to form AFMC.(51) The new commander of AFMC, General Yates, believes that all workers must have decision making authority in the acquisition process with the power to change obstacles to making quality products. An extended delineation of the exact methods and techniques used by AFMC to implement this charter is beyond the scope of this manuscript.

Defense acquisition processes have many quality management programs built in. The bulk of the processes lies in the hands of the contractors that actually produce the weapon systems. The DoD has openly endorsed quality management improvements with its contractors. However, the efficiency of these quality management programs is questionable. For example, at one large defense contractor, one senior official stated that his company has a ..."TQM program to get awarded government contracts and [that] the program is mostly eyewash for government officials."(52) Nonetheless, Air Force Logistics Command won the President's Award for Quality and Productivity Improvement in a government-wide competition in 1991. Since then, the Defense Department is well on its way towards adopting and internalizing TQM as the way it does business. Integrating AFLC and AFSC into AFMC is probably the most significant application of TQM since former Secretary of Defense, Frank Carlucci adopted TQM as the way the Pentagon would do business.(53)

The pivotal role of quality improvement efforts in acquisitions lies in establishing contracts with defense manufacturing firms. The DoD has been writing contractual clauses covering "value engineering." Value engineering is a concept embodied contractual provision that provides financial incentives to defense manufacturers to find manufacturing process improvements in already established contracts. The defense firm then gets a share of the savings to the government when the process is modified to incorporate the suggested process improvements. Clearly, value engineering has many potential quality improvement gains provided the program is run competently. This program has been around for almost two decades and has often been found to be ineffective.(54) It would therefore have to be re-emphasized and more closely monitored in order for it to achieve its full potential.

The DoD has cited several problems with the value engineering program which could be improved upon. First, is a lack of awareness among government and industrial officials that the program exists. Often, those who manufacture new weapon systems are not aware of the value engineering contractual provisions.

Second, government and defense industry workloads are too high. Many officials and workers simply do not have the time nor the motivation to look for optional cost savings. Third, the government is slow to evaluate and process those improvement proposals which have already been submitted. Sometimes it has taken over twice the 45 day target time to get the submitted proposal acted upon by government officials. Past inefficiencies in managing the system provide disincentives for contractors.

The DoD, under President Bush, implemented some administrative changes designed to improve the acquisition process. He established the Defense Management Review to streamline the acquisition process in 1988. This high-level panel has been effective in increasing efficiencies in some areas of acquisitions. For example, acquisition decisions that used to take several months later were made in about 48 hours. And, redundant regulations have been modified or removed. This review panel has also mandated reduced headquarters staffing in some military organizations to increase efficiencies as well. Despite these improvements there is still much room for better performance. For example, in 1992 Congress required 734 one-time reports on acquisitions. The Defense Management Review is setting its efforts toward reducing this workload.(55)

NATIONAL SECURITY AND DEFENSE: CLINTON AND ASPIN

What do we know about how President Clinton and his new Secretary of Defense, Les Aspin, will approach national security, and the world of defense acquisitions? In September 1992, Georgetown University released its analysis through its National Security Studies Programs and Global Security Project. Under the leadership of Loren B. Thompson, a report entitled: "Bill Clinton's Views on National Security: An Assessment" was released. Highlights of this report provide a relevant frame of reference for analyzing defense acquisitions over the next several years.

President Clinton laid the foundation for his future defense policy in a December 12, 1991 speech at Georgetown University. In his speech, "A New Covenant for American Security" he noted that America has two great foreign policy challenges: 1)defining a new national security policy based on the Cold War victory; and 2) generating a new economic policy related to a new era of global growth. Surveying existing and potential capabilities and threats, Clinton's approach is matched against Bush's. Clinton favors a slightly smaller, more conventional, and more U.S. based force. He also seems more prepared to spend dollars on supporting the defense industrial base. With Bush's spending plans for $1.42 trillion and Clinton's at $1.36 trillion, there is only a 4% difference averaging approximately $12 billion per annum for 5 years through 1997 according to preliminary projected implementation plans.(56)

Clinton's defense posture turns out to be quite middle of the road. His primary advisors on defense have been Senate Armed Services Committee Chairman Sam Nunn and then House Armed Services Committee Chairman Les Aspin. President Clinton has also made it clear that he believes there are many redundancies in the U.S. Armed Forces and that a reorganization of the military could reduce redundancies, get better teamwork, and save billions of dollars. Clinton believes a strong conventional force is important for our military future and has highlighted several conventional weapons programs as being important. These include: CVN-76, the next aircraft carrier (Ninety Class), the Air Force's F-22 fighter, the C-17 Airlifter which is the next generation military transport, the V-22 Osprey which is the Marine Corps' vertical take-off and landing aircraft, and the Navy's newest attack submarine, the Seawolf. Clinton also supports the Army's M-1 tank upgrade program.

President Clinton has supported Les Aspin's position as a proponent of a strong defense industrial base which becomes significant as becomes the Secretary of Defense. Look for projects that enhance both defense and economics infrastructure development. Clinton also looked to Aspin for more detailed ideas on how to address defense acquisition and downsizing issues. Clinton's policies may not necessarily be that significantly different than Bush's would have been under the changing circumstances. His particular approaches to implementing his policies will likely be quite different than the Bush Administration's, however.

In his assessment, Georgetown's, Loren Thompson presented a number of conclusions about Clinton's national security policies. They include the following: 1) Clinton would not substantially change current defense spending trends. $60 billion over five years is only about a 4% difference from the Bush Administration. 2) The deployment pattern of U.S. military forces would change. Clinton would base more forces in the U.S. requiring the development of a more significant airlift and sealift capability. 3) Military missions and roles are likely to be significantly reorganized to avoid duplication of activities and assets. 4) Conventional capabilities will be enhanced and strategic forces cut back. 5) Key industrial capabilities must be protected and promoting the integration of defense and commercial production to optimize greater efficiency and flexibility must be accomplished.(57)

TOWARDS A PRUDENT ACQUISITIONS POLICY

This assessment leads one to conclude that there will have to be changes made in order to optimize the adjustments to the transformations being experienced in the defense acquisition system. The management, policy and administrative forces creating the turbulence and change affecting acquisitions need to be evaluated and adjusted in order to maximize efficiency, economy and performance. Based upon the research done for this project, it appears that Clinton may draw much more significantly from the recent developments in management and policy like privatization, TQM, and reinventing government with their evolving entrepreneurial and participation enhancing mechanisms. Great care must be exercised to include business strategy considerations as well, in order that the significant transitions in acquisition community be managed in such a way that we promote an optimally prudent policy.

Note

This paper was funded in part by the Defense Systems Management College, Fort Belvoir, Virginia.

Dr. Van R. Johnston is a Distinguished Visiting Professor of Management and Strategy at the United States Air Force Academy; and a professor of Management, Business, and Public Policy at the University of Denver. His Ph.D. is from the University of Southern California.

Captain Robert J. D'Amico is an Instructor of Management at the United States Air Force Academy. He has a MGA from the University of Maryland and a BSBA from the University of Denver.

Endnotes

1. Deterrence in Decay: The Future of the U.S. Defense Industrial Base, The Center for Strategic and International Studies, Washington D.C., May 1989.

2. Gleckman, Howard, et al. "Clinton's Agenda: Will Microsurgery Get the Economy Moving?" Business Week, a McGraw Hill Publication, January 25, 1993, pp. 28 - 32.

Harbrecht, Douglas. "Drafting a Dream Team: Clinton's Presidency Depends on His Picks," Business Week, A McGraw Hill Publication, November 23, 1992, pp. 28ff.

3. Verity, John W. "Deconstructing the Computer Industry," Business Week, A McGraw Hill Publication, November 23, 1992, pp. 90 - 100. This is but one of many examples available.

4. Kerwin, Kathleen, et al. "Crisis at GM: Turmoil at the Top Reflects the Depth of its Troubles," Business Week, a McGraw Hill Publication, November 9, 1992, pp. 84 - 86.

5. Barker, Robert and Verity, John W. "A Question of Value: Our Analysis Finds Big Blue May Be Cheap," Business Week, a McGraw Hill Publication, January 18, 1993, and Verity, John W.

6. Johnston, Van R. and D'Amico, Robert J., "Total Quality Management and the Reorganization of the Air Force," a National Conference Paper for the American Society for Public Administration's 53d National Conference, Chicago, April, 1992.

7. Shine, Eric and Borrus, Amy. "Defense: Nowhere to Run, Nowhere to Hide," Business Week, a McGraw Hill Publication, January 11, 1993, pp. 30 - 31.

8. Rich, Michael, et al. Improving the Military Acquisition Process: Lessons from Rand Research, Rand/R-3373-AF/RC, Santa Monica, CA, February 1986.

Donahue, John D. "Lessons from the Pentagon" in The Privatization Decisions: Public Ends, Private Means, New York: Basic Books, Irwin Publishers , 1989, pp. 126 - 127.

Cochrane, Charles B. "DoD's New Acquisition Approach: Myth or Reality?" Program Manager, July - August, 1992, pp. 38 - 46.

9. Lundquist, Jerrold T. "Shrinking Fast and Smart in the Defense Industry," Harvard Business Review, November-December 1992, p. 76.

10. Ibid., p. 78.

11. Kuhn, Thomas S. The Structure of Scientific Revolutions, 2nd ed., Chicago: University of Chicago Press, 1970.

12. Rich, Op Cit.

13. Cochrane, Op Cit.

14. Deterrence in Decay: Op Cit.

15. Air Force Restructure, White Paper, September 1991.

16. Cochrane, Op Cit.

17. Ibid.

18. Rich, Op Cit.

19. Cochrane, Op Cit.

20. Ibid.

21. Air Force Restructure, Op Cit.

22. Yockey, Don. "Defense Acquisition" This is a memo with twenty four pages of attachments from the Undersecretary of Defense to top level officials outlining DoD changes regarding defense acquisitions resulting from the dramatic changes in the national security environment. U.S. Department of Defense, May 20, 1992.

23. Savas, E.S. "Privatization in Post-Socialist Countries," Public Administration Review, Vol. 52, No. 6, November/December 1992, pp. 573 - 581.

24. Donahue, Op Cit., pp. 101ff.

25. Ibid. pp. 102 - 103.

26. Ibid., p. 111.

27. Ibid., p. 112.

28. Ibid., pp. 112 - 113.

29. Shine, Eric and Borris, Amy. "Defense: Nowhere to Run, Nowhere to Hide," in the manufacturing section of Business Week, a McGraw Hill Publication, January 11, 1993, p. 64.

30. Donahue, Op.Cit., pp. 113 - 114.

31. Lundquist, Op. Cit., pp. 78ff.

32. Donahue, Op. Cit., p. 124ff.

33. Schneider, Keith. "Firms Waste Billions Say U.S. Auditors," The Denver Post, December 12, 1992.

34. 31 U.S.C. 7501-7507.

35. Granoff, Michael H. "Privatization: The Road to Federal Regulation of Auditing," Accounting Horizon, Vol. 6, No. 4, December 1992, pp. 76 - 85.

36. Osborne, David, and Gaebler, Ted. Reinventing Government: How the Entrepreneurial Spirit is Transforming Government, New York: Addison - Wesley Publishing Company, Inc. 1992, p. 16.

37. Editors, "Reinventing government (sic)," Perspective The Denver Post, January 17, 1993, Section D, P. 1.

38. Ibid.

Port, Otis, et al. "Quality," Business Week, A McGraw Hill Publication, November 30, 1992, pp. 66ff.

39. Osborne and Gaebler, Op. Cit.

40. Johnston, Van R. "Privatization of Prisons: Management, Productivity, and Governance Concerns," Public Productivity and Management Review, Vol. XIV, No. 2, Winter 1990, Jossey - Bass Inc., Publishers, pp. 189 - 201.

41. Kuhn, Op. Cit.

42. Osborne and Gaebler, Op. Cit.

43. Goodgame, Dan. "A Prophet of Innovation: Author David Osborne Tells How to Reinvent Government and Fight Bureaucratic Bloat," Time, Vol. 140, No. 24, December 14, 1992, pp. 50 - 51.

44. Osborne and Gaebler, Op. Cit.

45. Johnston, Op. Cit.

46. Goodsell, Charles T. "Reinvent Government or Rediscover It." Public Administration Review, January - February 1993, Volume 53, No. 1, pp. 85 - 87.

47. Hudson, Neff. "Materiel Command: Risk Takers, Stockpilers Joining Forces," Air Force Times, June 29, 1992, pp. 12 - 13.

48. Ibid.

49. Hudson, Neff. "AFMC Focus is 'Cradle to Grave' Management," Air Force Times, June 29, 1992, p. 16.

50. Ibid.

51. Ibid.

52. An interview with a senior engineer, McDonnell Douglas Aircraft Corporation, March 12, 1992. (Interviewee wishes to remain anonymous).

53. Bond, David F. "Military Budget Drawdown Spurs Movement Towards Increased Efficiency," Aviation Week and Space Technology, December 9, 1991, pp. 58 - 59.

54. Fact Sheet Program Manager's Notebook, Published by the Defense Systems Management College, December, 1988.

55. Ibid.

56. Thompson, Loren B. "Bill Clinton's Views on National Security: An Assessment," The Global Security Project of the National Security Studies Program. Georgetown University, Washington D.C., September 28, 1992, pp. 1 - 24.

57. Ibid

GBI Success: A Steady Course Through a Sea of Stars Using Proactive Management

James C. Katechis and Reba S. Seals
Ground Based Interceptor Project Office, Strategic Defense Initiative Organization

ABSTRACT

This article addresses the successful management concept "model" employed by a major Strategic Defense Initiative (SDI) Program. The Army's Ground Based Interceptor (GBI) Project achieved all technical objectives, was within 7.3 percent of the original contract cost, and was successful in proving the stressing performance requirements for a low cost interceptor. The concept model of Integrated Proactive Management (IPM) is the keystone of the GBI Program Management philosophy. The concept is central to the effective and timely blending of technical, schedule, and cost parameters with the effective use of a precious limited resource, people. IPM suggests adaptive management tools and techniques used in a proactive rather than a reactive manner. Although there are many different tools and techniques used by the GBI Project Office for both internal and external management, the contract itself is a most important management vehicle. The contract is the formal means of communication between the government and the prime contractor and supporting industries. The appropriate amount of care is taken in preparing the prime contract and its associated clauses to assure that the requirements to manage the program are covered.

This article addresses the application of cost management incentives, subcontract reviews, make or buy decision reviews, and the contractor's total life cycle cost estimate by the GBI Project Office to help manage and influence both the prime and subcontractor elements. The article further outlines a format used by the government and contractors when recovery plans were required. Two new activities involving future applications in Make or Buy decisions and a Risk Management Process are discussed.

INTRODUCTION

The project management concept places full line authority for centralized management and direction of a high priority system in the hands of a single individual, the project manager. The actual concept generally involves a team approach consisting of a government component with the project office and other staff and government agencies, a prime contractor component with associated subcontractors and a government support contractor component emphasizing specific technical enhancements. The management approach promulgated to the team is a direct reflection of the management style of the project manager and the environment in which the project must function. The team prudently expects frequent environmental change and anticipates project manager tenure with subsequent management style consistency.

The Ground Based Interceptor (GBI) Project Office, which is a continuation of the Exoatmospheric Reentry Vehicle Interceptor Subsystem (ERIS) Project Office, is an example of the process. The ERIS project manager, a Department of the Army Civilian, was assigned in December, 1984 and still serves in that capacity for the GBI Project Office. The PM's style of management evolved immediately with the drafting of a transition team, the preparation of a request for propos^l and the formulation of a source selection structure and process. A PROACTIVE style of management became the mood at the project office. Independent thinking was expected, "yes-men" were discouraged and the Economic Man Theory of maximum benefit for the dollar was required. Risk reduction, along with cost, schedule and technical realism were embedded in the thought process. It became evident that from top management down it would be a team approach requiring active involvement from each participant.

For all practical purposes, the program began in 1986 when the Project Office was established, support contractors were brought on board and the prime contract was signed in January. The PM officially published his Management Plan in which he stated:

> "We only get one chance to start the ERIS program right. It is therefore necessary that we now make clear our overall plan for managing ERIS - a plan which defines the objectives, tools and techniques required for a "proactive" team. The SDC commander has placed special emphasis on PM management of technical matters, schedule, cost schedule/control and contract administration and for using the "sleeping bag" (close to the contractor) method of managing prime contractors. My response has been to task each ERIS Project Office Division Chief with the full responsibility for technical, schedule, cost and resources (manpower) in his assigned area. We now must execute according to plan, anticipate problems, bring the best brains in our country to bear on the key issues and dig to the level of detail required to hit rock. In brief, we will get in close, stay in close as an interactive team and let our system of checks and balances indicate the area where our limited resources can best be spent each day. What is "our standard"? Let me explain by saying any team can react to a problem - that's "firehouse management," but the ERIS Project must take steps to ensure that the program gets the edge or margin required for "proactive" leadership."

This approach was applied to the entire ERIS team. A Work Breakdown matrix was formulated which identified every element to three tracking managers - a government manager, a prime contract manager and a support contract manager. Each element manager was expected to know and manage the element and be measured, evaluated and rewarded or re-motivated relative to performance by the appropriately tiered authority. The prime contract emphasized the generally accepted items of technical, schedule and cost objectives along with management information such as Cost Performance Reporting, the Work Breakdown Structure and Milestone Event tracking. It also imposed a stringent program network tracking system which transitioned into network uncertainty analysis and RECOVERY PLAN/ workaround considerations. Added to the bag of tools was:

- CONTRACTOR TOTAL LIFE CYCLE COST ESTIMATING REQUIREMENT,
- low life cost per kill goal development,
- MAKE OR BUY DECISION REVIEW,
- monthly status reviews,
- parallel development of high risk hardware items,
- early trade studies,
- low cost booster development,
- SUBCONTRACTOR REVIEW,
- COST MANAGEMENT INCENTIVES.

A synopsis of those highlighted proactive techniques are presented in subsequent paragraphs.

COST MANAGEMENT INCENTIVES

The contractual instrument that was executed, dramatically complimented the proactive style of management called for in the PM's Management Plan. It provided for payment of incentive fee on the basis of cost performance. The contract established target cost, target fee, and a 75:25 government to contractor share ratio for overrun/underrun costs. Based on the share ratio, a maximum potential fee was established for a low cost underrun, with zero minimum potential fee for a high cost overrun (Figure 1).

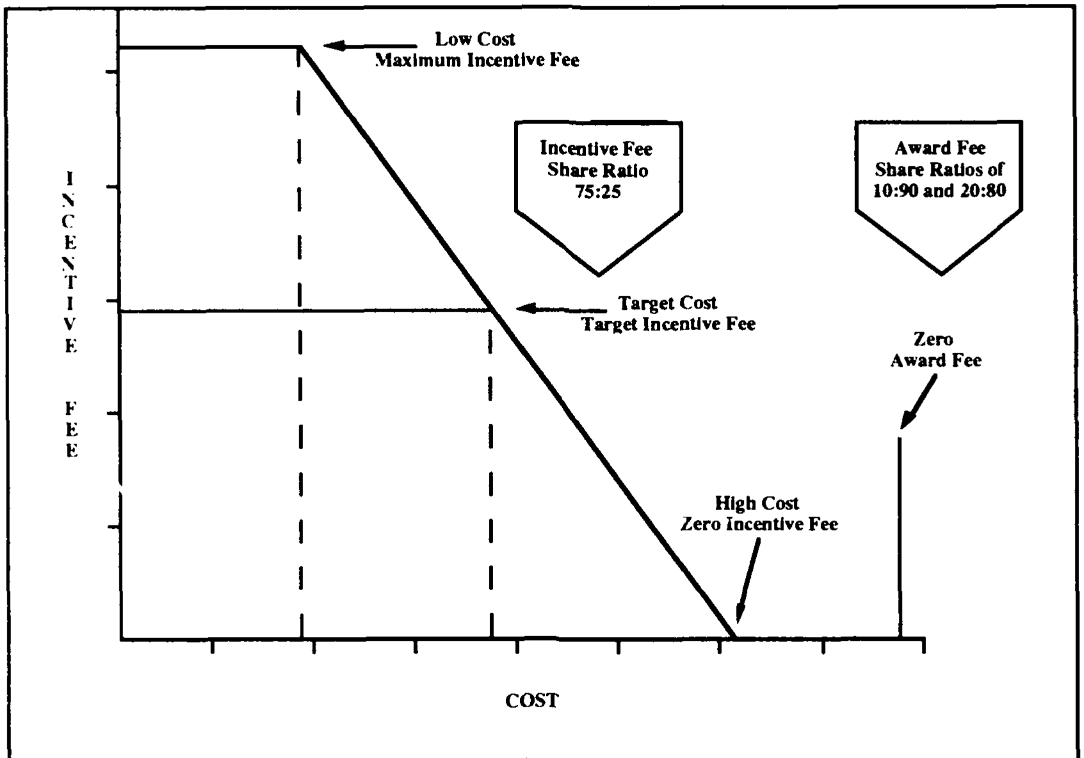


Figure 1 - Fee/Cost Relationship

The contract provided for the payment of award fee based on technical performance, including flight tests, and management performance. Management performance included but was not limited to: planning, organizing, and controlling resources; balancing resources, schedule and technical performance to achieve objectives; reporting accurate and timely data and cost information; identifying and projecting solutions to potential and actual problems in a timely manner; managing subcontractors, and providing general responsive program support. The contract linked specific milestones to award fee periods for specific durations of time and a relative distribution of the total award fee (Figure 2).

MILESTONE	PERIOD NUMBER	DURATION IN MONTHS	PERCENT OF TOTAL
SDR	1	11	10
PDR	2	8	10
CDR	3	11	10
Verification Test	4	20	30
Contract Completion	5	10	40
TOTAL		60	100

Figure 2 - Potential Award Fee Distribution

If a milestone was not accomplished on time, the period remained open until it was accomplished. The fee not earned for each period was lost for succeeding periods; however, it rolled over to a pool which could, at the discretion of the fee determining official, still be received at the end of the contract. The evaluation process was disciplined and formal. The contractor provided a written self assessment covering accomplishments within ten work days after the end of the period. Award fee determinations were not open to formal dispute. The motivational effectiveness of this tool cannot be understated. The prime and subcontractor team demonstrated the value of the potential benefit offered via the award fee, by insisting that each of their employees be made aware of their personal contribution by correlation to career performance measurement.

The level of motivational intensity was further raised by the COST MANAGEMENT INCENTIVE clause in the contract. It provided that if actual contract cost exceeded the high cost estimate, the point at which incentive fee

was already reduced to zero, then the government could provide additional funds to continue the effort and invoke the clause. It provided for application of a cost share ratio and withdrawal of Previously Earned Award Fee (PEAF). See Figure 1. Specific application addressed several tiers of overrun:

- For costs greater than the HIGH COST estimate and not more than one hundred twenty percent of TARGET COST, the contractor's share would be ninety percent of the overrun until one third of the PEAF was consumed. If enough PEAF was not available, the contractor's share deficit would carry over to the next award fee period.

- For costs greater than one hundred twenty percent but less than one hundred twenty four percent of TARGET COST, the contractor's share would be eighty percent of cost until PEAF was consumed.

- For costs greater than one hundred twenty four percent of TARGET COST, award fee would be zero and all PEAF not previously consumed would be returned.

Points to remember are that the award fee must be large enough to attract attention; one method of evaluation should be fair to both parties; the evaluation criteria should be understood and promulgated from the beginning; and that recovery is possible. The arrangement should benefit both parties. It is not something the contractor should assume is an absolute given, regardless of performance, nor should the government feel a compulsion to withhold, regardless of performance. The intent is that it be a win - win situation for both parties that is entered into in good faith. It is a strong motivational tool. If the dream of a potential award fee can motivate, and the mere thought of not receiving the maximum available fee can rededicate management attention, then the nightmare of giving back all or part of previously earned award fee will invoke absolute panic.

SUBCONTRACTOR REVIEW

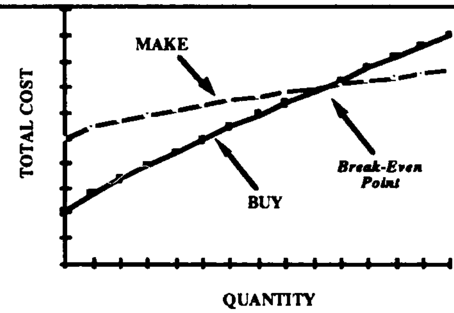
The contract established a subcontract review cycle that involved project office participation. The requirement did not shift or diminish the prime contractor's management responsibility but enhanced the government's position in the loop. The government received all subcontract solicitations whose estimated cost exceeded $4M, as well as certain other key solicitations falling under that threshold which were of special interest. Each submission included sole source justification or evaluation criteria. Fifteen days prior to the award of a subcontract covered by the clause, the prime contractor furnished the Procuring Contracting Officer documentation supporting the recommended selection. The subcontract could not be awarded without government consent which was required within the fifteen day period.

Other independent, yet interrelated, contractual requirements were centered on the subcontract process. Trade studies were required during the early months of the contract. A Recompetition of Subcontracts clause required that as a result of the trade studies, recompetition of prearranged agreements for certain components, including seekers, might be required. It further stipulated that the requirement for recompetition would not be a cause for adjustment to the contract amounts, performance schedule or other contract provisions. A Parallel Technology Development clause required that, as a result of the trade studies, certain parallel technology component development might be required. The seeker component was active in all facets of the process - the subcontract review, trade studies, recompetition of subcontracts and parallel development. Since the seeker was considered to be one of the highest technical, schedule and cost risk items in the program, it was selected as a risk mitigating dual source item. The downselect decision, scheduled for month forty-four, again invoked the subcontractor review process.

MAKE OR BUY DECISION REVIEW

The contractor was required to provide the rationale and quotes supporting all make or buy decisions for hardware WBS elements level three and below, which were estimated to cost more than $3M. The internal methods and procedures for determining make or buy decisions were identified in a make or buy plan submitted with the proposal and accepted at contract award. The buy alternative had to be supported by a description of competitive actions or sole source justification. Decisions were presented to the government for consent with responses to be returned within fifteen days. The process was successful, stressing the importance of economic trade-offs in the relationship to sound business base decisions.

The project office plans to enhance its future efforts in this area. The standard questions relating to quantity, quality, manufacturing, supply, and cost that affect make or buy decisions are addressed; however, a concentrated effort will be made to model a projected break-even (BE) point for make or buy analysis. One methodology being considered is the bisection algorithm from the field of numerical methods which address non-linear models. Eleven separate cost relationships may be evaluated in the methodology. The model addresses fixed/start-up cost and variable cost, forcing the thought process of Marginal Theory and Economy of Scale. Figure 3 reflects a potential output and cost relationship. The BE point is just one of the variables which will be addressed. Other evaluating points include business base expansion, ability to produce, desire to enter into a particular environment, quality of product, importance of item, etc.



A cost relationship to address "make" and "buy":

$$\begin{pmatrix}\text{Total}\\ \text{Cost}\end{pmatrix} = FC + A\left(\frac{(X+.5)^{B+1} - (.5)^{B+1}}{B+1}\right)$$

Where: FC = Fixed Cost
A = Theoretical 1st Unit Cost
X = Quantity
S = Slope

$$B = \frac{\ln(S)}{\ln 2}$$

Figure 3 - A Non-Linear Make or Buy Model

CONTRACTOR TOTAL LIFE CYCLE COST ESTIMATING REQUIREMENT

Early in the program, the PM challenged the government System Engineering Division to field a configuration that was cost effective in total life cycle cost and cost per kill. Rather than "arm wave" at the concept, specific actions were initiated to move in that direction. The prime contractor's System Engineering office was established as a mirror image of its government counterpart. An Operations Research Analyst, dedicated to cost analysis and dealing with life cycle cost issues, was added to that organization. The contractor was required to develop, deliver and periodically update, a fully documented life cycle cost estimate. A government designed PC model was utilized facilitating data interchange. The estimate conformed to Army Cost Analysis regulations and procedures, as did the project office Baseline Cost Estimate (BCE). The estimates were compared, tracked and evaluated by the project office in a manner similar to the Independent Cost Estimate - BCE track. The requirement focused the contractor's attention on the idea of total life cycle cost

and involvement beyond the instant contract. It provided an appreciation for long range government planning and prognostication, enhancing overall support for the acquisition process. An added benefit was that cost modeling was utilized by the contractor to evaluate early design trade studies that not only affected developmental hardware but assessed impact on subsequent production and operational phases. Cost awareness permeated the contractor's functional offices and projected the Economic Man Theory to the forefront.

RECOVERY PLAN

The Project Manager's Internal Status Review, a structured process (Figure 4), focused management attention and corrective action toward problems, potential problems, trends or special items of interest.

The review, conducted monthly, was presented to the PM and Deputy PM by project office Division Chiefs and WBS government managers. The briefing format included a number of standard charts supplemented by special charts. The briefing started with an overview of the top level summary of the Cost Performance Report (CPR). Next came a three section SNAPSHOT OVERVIEW chart (Figure 5) with the first section reflecting the status of funds received, obligated and expended. The second section was a level one CPR summary of three months history and six months projection for both cost and schedule variances. The third section was the project manager's top areas of concern. The concern items were individually identified by title and date of first appearance on the PM's list and expected resolution date. A Management Reserve curve status chart tracked actual application against the cumulatively diminishing goal of CPR management reserve measured at specific milestones on a time line. The intent was to have a specified amount of MR available as the system entered each successive period. A Milestone Status chart tracked cumulative milestones scheduled and completed and the status of delinquencies. The segment devoted to DIVISION CHIEF STATUS AND CONCERNS and WBS MANAGER PRESENTATIONS contained standard charts relative to lower level WBS elements of the CPR, network and schedule.

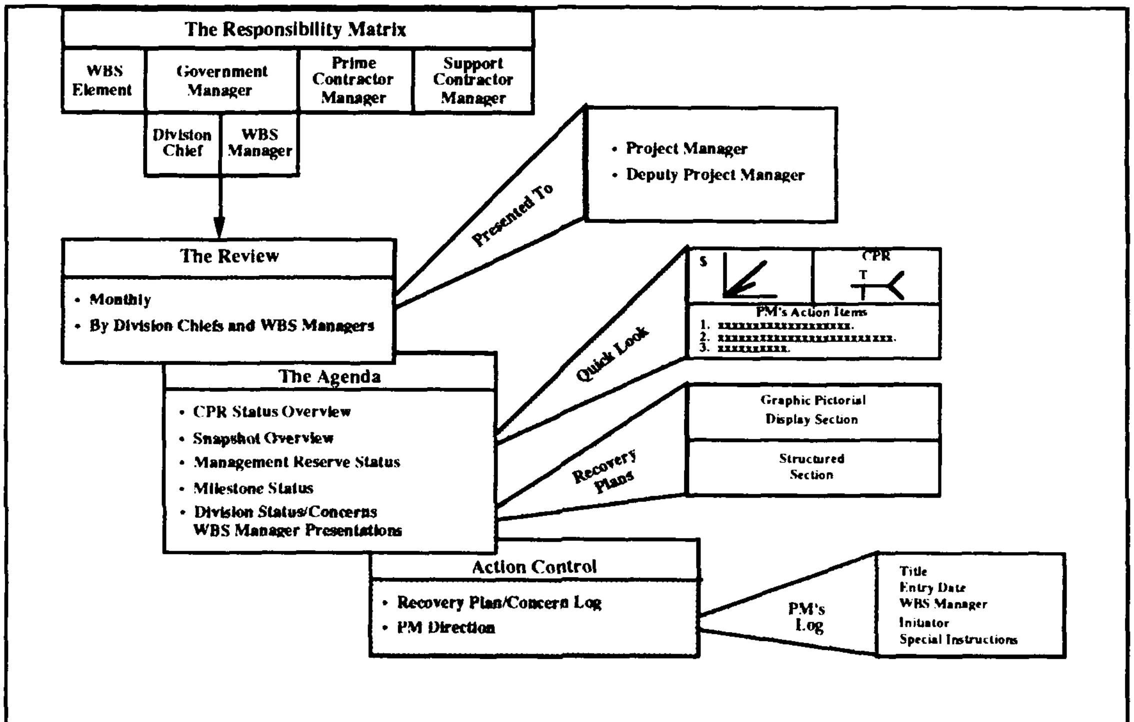


Figure 4 - Project Manager's Internal Status Review

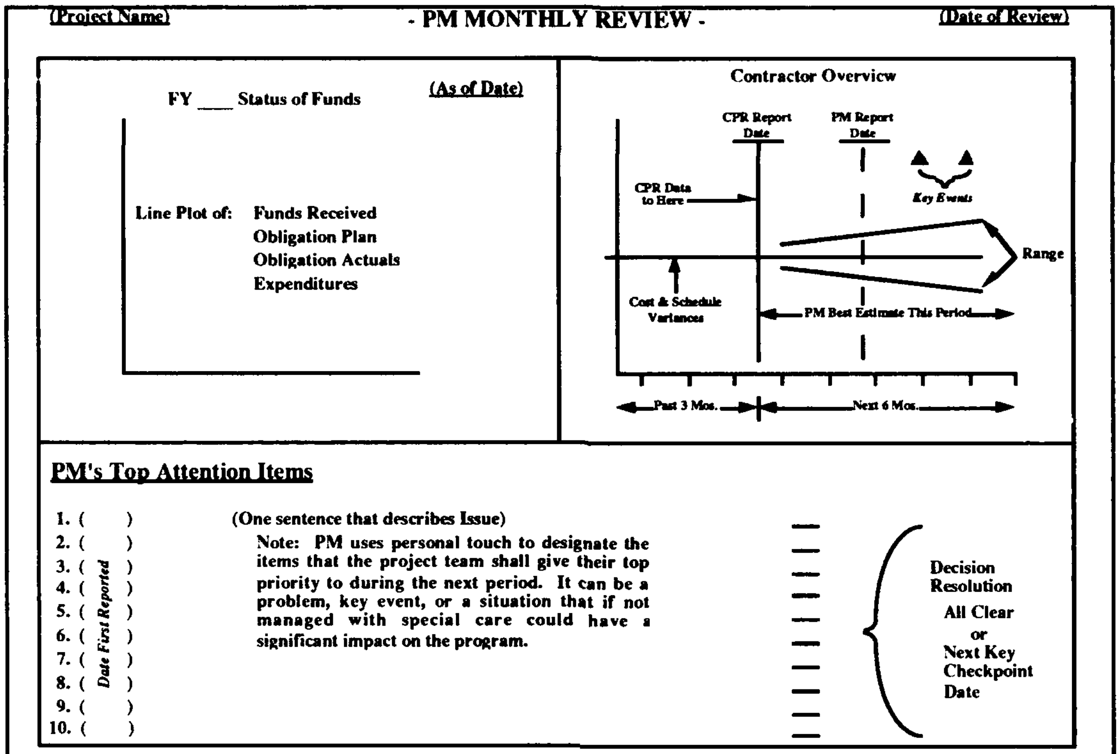


Figure 5 - Snapshot Overview

Also included were uniquely designed charts and the required *RECOVERY PLAN charts.* The Recovery Plan structure was an integral part of the process. It was used as a vehicle to obtain, focus and maintain management attention on cost, schedule and technical status and corrective actions related to a specific problem. The format (Figure 6) was specific, yet broad enough, to cover most of the elements in this section of the briefing. The Recovery Plan chart was divided into different sections and was limited to one or two pages with associated backup charts being acceptable. The top section of the chart included the identification control number, date first reported, title, date of projected decision or resolution and date of briefing. The next section of the chart was devoted to a pictorial, graphic or visual display of the topic, problem and recovery/workaround solution. The bottom part of the chart contained a more detailed word display covering the issue, impact, solution, key events, status and responsible WBS Manager.

The agenda and briefing elements evolved from CPR threshold breaches or significant trend movement, the network and milestone *tracking system*, assigned topics from the PM, key events or activities (e.g., Critical Design Review), PM briefings and meetings involving the project office team, WBS manager presentations, Division Chief status presentations, the prime contractor's monthly In-Process Review (IPR) and the Recovery Plan/Concern Log. Specific actions resulting from the monthly briefing were recorded and tracked in the RECOVERY PLAN/CONCERNS LOG and were added or removed at the PM's direction. Items tracked by the process ranged from Housing at the Kwajalein Atoll site to a potential flight delay associated with the air vehicle destruct initiator. An actual chart used during that time, depicting the computer module recovery plan, is shown at Figure 6(A). The recovery plan concept was adopted as an internal management tool by the prime contractor and often utilized in the monthly IPR presented to the government.

1. (Date First Reported)	(Copy Issue Statement from Snapshot Chart - (<u>Date of Resolution</u>)	(Current Date of Briefing)

This space is used for a chart, graph, or picture that summarizes the problem, solution, status and impact.

Note: Status is new each period.

Model Only

<u>ISSUE:</u> An expansion of the issue statement to provide perspective by adding specifics in quantified terms where possible.

<u>IMPACT:</u> The engineer or manager responsible provides his best estimate - may be an educated guess - as to the cost, schedule, performance and other impacts.

<u>SOLUTION:</u> What must be done to resolve the issue successfully - A logic, strategy or specific tasks are appropriate - quantified if possible.

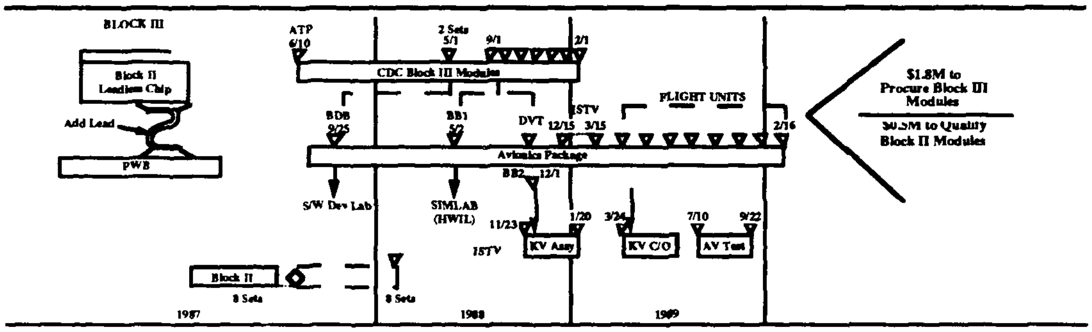
<u>KEY EVENTS:</u> Key event dates may be added to solution - the final decision date or resolution date here. Between solution and key events, the indicators and their dates shall be made clear.

<u>STATUS:</u> Using the above indicators, provide a status as of the submitted date. This may be marked above and noted as status. The objective is to feel the pulse of the manager/engineer vs. adhere to a rigid format.

<u>RESPONSIBLE:</u> Individual in project - Title - Telephone Number - Office Responsible

Figure 6 - Recovery Plan

(8-87) RELIABILITY OF CONTROL DATA CORP AN/AYK-14 COMPUTER MODULES (August 87)



<u>ISSUE:</u> Reliability of Block II Modules is Questionable.
Schedule for Block II Deliveries has no Slack.

<u>IMPACT:</u> Procure Block III Modules - $1.8M. Retain Block II Modules as Backup - $0.5M.
Delay of ERIS Program - $6M Per Month.

<u>SOLUTION:</u>
A) Procure Block III Modules as Preferred Option.
B) Retain Procurement of Block II Modules as Backup.
C) Develop Workaround for Initial ISTV Activity.

<u>KEY EVENTS:</u>

A) Block III Procurement Decision	Jun 87
B) Block II Buy-Out Decision	Aug 87
C) Block III Verification Tests Complete	Oct 87
D) Block III Reliability Demonstration Complete	Dec 87
E) Decision to Qualify Block II for ERIS	Jan 88
F) Deliver First Block III to Honeywell	Apr 88

Actual Example

<u>STATUS:</u> Go Ahead for ERIS Block III Production on 10 Jun 87.

<u>RESPONSIBLE:</u> John Wymer - Avoinics Project Engineer - 895-4915

Figure 6(A) - Computer Module Recovery Plan

The Internal Status Review, in order to be effective, must be open to new topics and procedures. As part of this process, the project office plans to expand the subject of risk management. MIL-STD-499B, Systems Engineering Management, outlines an idea that focuses on Technical Performance Measurement (TPM) and encourages the integration of TPM and Cost Performance Reporting (CPR) data. One approach being evaluated is the Integrated Risk Analysis that addresses Management Focus, Technical Performance, Cost and Schedule Performance and Risk Exposure. The model currently evaluates CPR, cost and schedule variance, and multiple parameter technical performance status by WBS element. A Management Focus chart (Figure 7) will provide the PM with a single top level summary measurement of the project's overall health. The mathematically derived measure shows management how focused they are by calculating the correlation between high technical priority, high technical performance, and low combined adverse cost and schedule variances. The risk exposure calculation ties together the technical, cost, and schedule performance measures with management focus and provides a measure of relative risk exposure. The measure ranks the selected WBS elements and assigns each a risk weight (Figure 8). The WBS elements with the highest weights are those that put the project at greatest risk. High risk exposure elements have high technical importance, poor technical performance, and a high combined adverse cost and schedule variance.

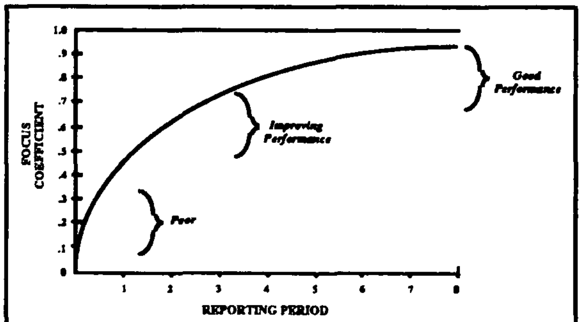


Figure 7 - Management Focus

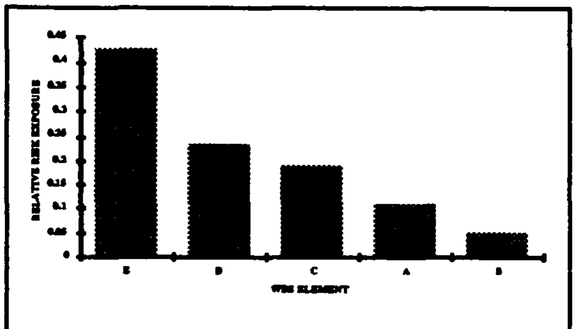


Figure 8 - Relative Risk Exposure of WBS Elements

CONCLUSIONS/SUMMARY

The topics presented are a small sample of the GBI project's Integrated Proactive Management (IPM) philosophy. Senior project office officials believe that the process and motivational aspects are highly significant and that micro level specifics and results follow.

A bottom line question must relate to how successful (or, in an imperfect world, the degree of success) the IPM philosophy was in helping the GBI project achieve cost, schedule, and technical objectives. The process of planning for success began in GBI prior to the release of the ERIS Functional Technology Validation (FTV) program request for proposal. The actual tracking for success started in January 1986 with the FTV contract award to Lockheed Missiles and Space Company (LMSC). Just as with most programs, ERIS went through numerous program perturbations, including the San Francisco Earthquake of 1989. Throughout the entire period of performance, the team met each challenge in a scientific, businesslike manner, keeping the objective balanced with the urgency of the situation and economic impact. The team would not be pushed into panic management. Daily and monthly problems were managed with the end product of success in mind. The Project Manager's statement, **"Don't fail on time"** had a leveling effect.

The areas of cost and schedule performance were deemed highly successful, maneuvering through a maze of funding cuts and uncontrollable external adjustments. Cost realism was an early concern of the project office, as evidenced by an article written by a GBI employee, John E. Liston. The article appeared in the September - October 1987 issue of the *Program Manager*, published by the Defense Systems Management College and was entitled, "Taking A Better Aim At Cost Realism Measures." It addressed the source selection cost evaluation process and cost realism as it related to ERIS FTV. Included in the article was a figure entitled "Government Contract Risk Curve" which addressed contract cost as envisioned at that time. An extract of the curve is shown in Figure 9, with, the final results superimposed on the original data. The 60 month contract, signed in January 1986 for $466M, was completed 17 months late for $500M. The first flight against a target, scheduled for June 1990, was actually flown in January 1991, 7 months late. It is interesting to note that while the contract period of performance grew 28 percent, the cost delta was only 7.3 percent greater than the original contract price and was near the SSEB mean of $496M. A $60M funding cut early in the program had a ripple effect on subsequent schedule activities. The cut forced an early selection of a single contractor for a risk mitigating dual source seeker program. As a result, problems with several seeker components contributed to the program delay and price growth.

The technical program objectives established at the very beginning:

- Tactical design of a low life cycle cost midcourse interceptor
- Functionally emulate tactical design using existing technology
- Selecting a target in the presence of decoys and closely spaced objects
- Lethality versus the reentry vehicle
- Determining intercept phenomenology

were also met with outstanding success.

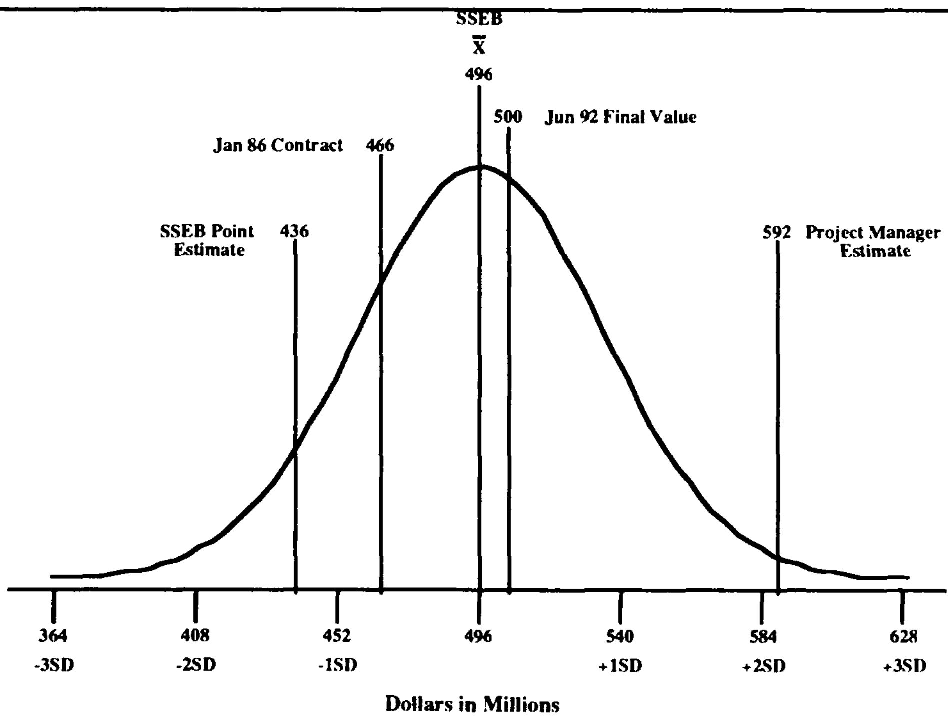


Figure 9 - Government Contract Risk Curve

In summary, IPM as applied in the GBI Project Office is not intended to overmanage the prime contractor, support contractors, or government team; however, it is intended to establish and maintain the proper degree of presence and leverage throughout the management and decision process. It represents the comfort zone and style that this management team views as prudent and responsible. The functions of the manager to plan, organize, direct and control, at the properly established level, is the project office dictum.

An October 1992 memorandum from the Army Acquisition Executive, strongly endorsed by the GPALS Program Executive Officer (PEO), emphasized a Team Concept based on the premise that both government and contractor share a common goal in management efforts.

> "Our vision of team management is pulling together all the right people, from government and industry, that have management authority and responsibility for a program to form an accountable team that is success oriented. We want to get top level management involved earlier, and have the right people on the team to resolve problems quickly with minimum cost and time impact. In other words, those individuals who expect to ultimately "grade the paper" are expected to help "write the paper" up front. The team will be expected to define critical processes and identify management actions required to ensure program success."

The perpetually evolving style of Integrated Proactive Management has worked for the GBI, fits within the AAE's Team Concept and will transition the Ground Based Element of GPALS to a successful future.

ENDNOTES

The Ground Based Interceptor (GBI) Project Office is a continuation of the Exoatmospheric Reentry Vehicle Interceptor Subsystem (ERIS) project. The GBI is an element of the National Missile Defense (NMD) segment of the Global Protection Against Limited Strikes (GPALS) System.

James C. Katechis has served as Project Manager for both ERIS and GBI. He graduated from Auburn University and has had extensive training at DSMC, the Industrial College of the Armed Forces and the Harvard Graduate School of Business. He has received numerous awards including: the Auburn University Engineer of the Year; two awards for the Most Significant Achievement in Strategic Defense, one from the American Preparedness Association, and one from the National Society of Professional Engineers; the Meritorious Civilian Service Award; and the Presidential Rank Meritorious Service Award. He is a major proponent of Integrated Proactive Management.

Reba S. Seals is Chief of the GBI Program and Acquisition Management Division. She graduated from Martin Methodist College and Athens State College with high academic honors. Ms. Seals has been recognized for her outstanding contributions to the GBI Project Office and the U.S. Army Strategic Defense Command, recently receiving the Commander's Award. Ms. Seals has been a key pivot in promulgation and implementation of the Project Manager's Integrated Proactive Management philosophy.

THE WEAPON SYSTEM WARRANTY REQUIREMENT AND COST-BENEFIT ANALYSES

Donna E. Kehrt
C-17 Depot Support Equipment Acquisition
Wright Patterson Air Force Base

Norman Ware, DBA, CFPIM
the Air Force Institute of Technology
Wright Patterson Air Force Base

ABSTRACT

This research was conducted to: (1) examine the history of the weapon system warranty (WSW) requirement; (2) assess the relevancy of warranties to dormant weapon systems; (3) review the current practices concerning the performance of a cost-benefit analysis (CBA) to support the waiver of a warranty for a dormant weapon system; and (4) identify factors that affect the warranty cost-benefit analysis (CBA) for a dormant weapon system.

The Defense Federal Acquisition Regulation Supplement (DFARS) and Air Force regulations require that a CBA be performed prior to the purchase of a warranty. The program manager makes the warranty purchase decision based upon the CBA. If the analysis is not performed adequately, the decision may be based on erroneous results; therefore, CBAs must be accurate.

Dormant weapon systems are a unique category: they are non-operating, non-reusable, and non-restorable. The systems are destroyed upon use in the field, and that fact poses serious difficulties in performing warranty CBAs for such systems. Some dormant weapon systems were examined, and factors used in performing the CBA for each program were identified and are reported in this paper (See Figure 1).

INTRODUCTION

For a major weapon system, the cost of a warranty can be a significant portion of total system cost. Therefore, a cost benefit analysis (CBA) which examines the cost-effectiveness of a proposed warranty is a necessary internal control measure. Without an adequate CBA, the government may spend funds on warranties that are not cost-effective. If the analysis does not justify the purchase of a warranty, a waiver should be requested. Several government organizations have found deficiencies in CBAs, and have recommended improvement of the analysis process.

THE HISTORY OF AIR FORCE WARRANTIES

The history of Air Force Warranties is rooted in the history of Department of Defense weapon systems warranties in general. The warranty provision was mandated by public law after Congress voted in 1983 to require manufacturers to provide weapon system warranties. The requirement stemmed from the procurement "horror stories" in the early 1980s,

and was spearheaded by Senator Mark Andrews, a republican from North Dakota. [4] Much debate about the issue occurred at the Armed Services Hearing in February 1984, and several witnesses, including Secretary of Defense Richard D. DeLauer, the chief Pentagon witness, spoke against the proposed law. [4] In general, it is believed that warranties do not provide incentives to contractors to make improvements in technology beyond what is required by the warranty. This sentiment was expressed by Air Force Lt. Gen. James W. Stansberry who warned the panel, "Once modest, unchallenging [performance] goals are set, they tend to become self-fulfilling prophecies". [4]

Contractors presented several arguments against the proposed law: The Department of Defense, as well as the contractor, controls the design of a system; therefore, the government shares responsibility with the contractor in this area. [4] Warranties discourage innovations and breakthroughs in technology. [4] Critical differences exist between commercial and military equipment, and these differences were not being considered. [2]

Still, Sen. Andrews was unrelenting in his efforts. Congressional interest remained high, and the public law was passed as part of the 1984 Defense Appropriation Act. The law requires each prime contractor for the production of a weapon system to provide written guarantees, starting with procurements after 1 January 1985. [2] The three types of guarantee covered by the law are 1) design and manufacturing, 2) materials and workmanship, and 3) performance specifications.

CURRENT GUIDANCE

1. Federal Acquisition Regulation (FAR), Subpart 46.7, FAC 84-58,
2. Defense Federal Acquisition Regulation Supplement (DFARS), Subpart 46.770-8, DAC 88-15,
3. Air Force Regulation (AFR) 173-15, Cost Analysis, 4 Mar 88, and
4. Air Force Regulation (AFR) 70-11, Acquisition Management: Weapon System Warranties, 1 Dec 88.

The public law is contained in 10 United States Code (USC) 2403.

THE COST BENEFIT ANALYSIS (CBA)

Affordability must be considered in relation to potential benefits derived from the warranty. AFR 70-11 contains guidance for implementing DOD policy on weapon system warranties in the Air Force, which policy requires that only cost-effective warranties be obtained. This means that a cost benefit analysis (CBA) must always be performed to ascertain whether or not a warranty would be cost effective for a given acquisition. Even if the contractor proposes a "no-cost" warranty, a CBA must be performed to compare the government's cost of administering and enforcing the warranty to the potential benefits to be derived from the warranty. [6]

The literature on this topic continues to address the shortage of guidance on how to prepare warranty CBAs, as well as the nonspecific nature of the guidance that does exist. There is a strongly felt need for valid CBA procedures.

The RAND Corporation published a report in 1987 regarding weapon system warranties. The report, which attempted to answer the question, "Can warranties help in improving weapon cost, schedule, performance, and reliability?" reviewed implementation and theory of warranties. [10] The authors were concerned that DOD was spending funds on negotiating, implementing, and enforcing warranties with no knowledge of the cost-effectiveness. The report found that ". . .there [was] a real need for improved evaluation criteria and procedures." The report also expressed concern that waiver requests were not being submitted, and noted the need for more policy in this area. This strongly suggests that procedures may need to be improved and that a comprehensive review process may need to be implemented. [10]

Another RAND Corporation report on warranties, titled A New View of Weapon System Reliability and Maintainability, was published in early 1989. The report was primarily directed towards a review of reliability and maintainability weaknesses in Air Force systems, but it also addressed the cost of warranties. Further, the report took the position that there should be evidence of a connection between use of warranties and increased levels of reliability and maintainability prior to purchase of a warranty. As did the earlier RAND report, the 1989 report stated that the services were spending money without knowing whether or not benefits would be derived. Specifically, the report stated that "...data and contractual language are being gathered sporadically by various agencies...," and went on to conclude that no process for systematically gathering and coordinating information existed. [7] Warranty effectiveness cannot be evaluated if the essential data cannot be gathered.

In September 1989, following audits of three procurement activities, the United States General Accounting Office (GAO) published a report to the Secretary of Defense on DOD warranties. One purpose of the audits was to determine if cost-effectiveness analyses were being performed as required by both DOD and service regulations. [11] The GAO discovered that CBAs were either not being performed or were not being performed adequately, and therefore, did not support a valid conclusion that the proposed warranty was cost-effective. The report also stated that the services were not considering waivers as an option during the procurement process [11].

An Inspector General report titled, System Acquisition Management (SAMI) of Weapon System Warranties, dated 15 August 1990, reviewed several aspects of warranties, one of which was the CBA. The team found that none of the organizations reviewed had implemented a good CBA process, noting deficiencies in both the review process and the supporting data base. The report further suggested that deficiencies in the data base may render many CBAs invalid. The report recommended that action be taken to "Devise and build a data base of essential cost parameters and relationships to support effective warranty CBAs." [5]

Guidance for Performing CBAs. In 1991, the Air Force Communications Command at Scott Air Force Base published a Warranty Guide, which provides general information on warranties. A section titled, "What Should a Warranty Cost?" notes that "[i]t's difficult to say exactly what a warranty should cost". [1] The guide then suggests that the analyst should first ask the contractor what is covered, and also recommends the use of a life-cycle cost model. From there the

guide lists very general questions pertaining to potential costs and benefits that should be answered when using the model. No specific guidelines for performing the CBA are provided; the limited content of this warranty guide illustrates the need for stronger guidance for performing CBAs.

Writing in the Program Manager, and referring specifically to sole-source and cost-type acquisitions, Brigadier General Lewis E. Curtis said that weapon system warranties do not make sense in every procurement situation. He further stated that unless a warranty can clearly be shown to be beneficial, it makes good business sense to pursue a waiver. General Curtis's position is especially relevant in the case of dormant weapon systems, because the nature of such systems is such that it is difficult, if not impossible, to show that a warranty is clearly beneficial. The authors think that it is in connection with this type of weapon system that guidance on the preparation of a valid CBA is most sorely needed. This is especially true with respect to the essential performance requirements (EPR) warranty, a concept which will be discussed below.

THE ESSENTIAL PERFORMANCE REQUIREMENTS WARRANTY

A system's EPR warranty typically drives the major portion of warranty cost. As a weapon system moves away from the concept exploration stage, the likelihood of influencing design to affect EPRs decreases. Once a system is in the engineering and manufacturing development stage, it is very costly for the contractor to improve essential system performance, whether or not it meets the requirements and the customer's expectations. When deficiencies are detected, whether through operational tests and evaluations (OT&E) or during the course of normal use after the system is fielded, warranty claims can be made. However, remedies vary with different contracts, and a test failure may not prompt the contractor to redesign a system to meet the EPR, even if it is clear that the failure is due to a faulty design. The contractor's analysis may indicate that it is more cost effective (from the perspective of the contractor) to pay the remedies for breaching the EPR warranty than to make an engineering change to the system to meet the EPR. Therefore, the warranty contract should specifically require redesign of a deficient system.

The design of a system and the manufacturing processes employed have a direct relationship to the EPR warranty. Reliability is designed into the system during the development stages. Manufacturing control processes can improve a system's reliability by detecting faulty workmanship and an inadequate manufacturing process. The manufacturing process can then be improved, resulting in a higher level of reliability. If EPRs are satisfactorily met, then it is likely that the other parts of the warranty would be positively affected.

EPR Selection. Operational performance requirements, which are derived from the Operational Requirements Document (ORD), form the basis for the EPR warranty. The ORD is prepared by the user or the user's representative. [6] The requirements for the EPR should be selected based on attributes that cannot be determined with certainty prior to or during acceptance testing. Verification of EPRs occurs during the operations phase after the system is fielded. EPRs should be measurable and verifiable in order to make valid claims and to perform valid CBAs. Availability, mission capability, and turn-around time are examples of potential EPRs. Clear and concise re-

quirements and measurements must be stated in the warranty. For example, a warranty may state the requirement for a mean-time-between-maintenance of 250 hours.

Essential Performance Parameters (EPPs). EPPs for a typical weapon system (for example, an aircraft engine that accumulates flying hours on a steady basis) are monitored continuously as the system performs in the field. On the other hand, EPPs for dormant weapon systems are difficult to monitor because they are not operated in field conditions on a regular basis. A dormant system usually undergoes a pre-acceptance test prior to delivery to the government. Following delivery the system is stored, and at some specified point in time, the depot may perform service maintenance on the system. Service maintenance may include replacing some components, or performing an external check for rust and humidity damage; it can include both replacement and external checks. The system may be tested at specified intervals, determined by the warranty contract, to verify the EPPs against the EPRs. Destructive testing is the only test option for some systems, while test sets can be used for other systems.

APPLICATION OF EPRS FOR SPECIFIC DORMANT WEAPON SYSTEMS

The EPR warranties for the Peacekeeper Missile Propulsion System, Advanced Cruise Missile (ACM), ACM Propulsion System, and Maverick Missile were reviewed. The following information was obtained for each system: 1) specific EPRs warranted, 2) type of tests performed to determine if a breach in EPR warranty has occurred, and 3) program office comments about the EPR warranty.

Peacekeeper Missile Propulsion System. The specific EPRs covered under the warranty were: action time, total impulse, instantaneous thrust, thrust tail-off, ignition delay, thrust vector actuator (TVA) enable time, TVA action time, TVA slew rate, TVA duty cycle, stage IV duty cycle. The test performed was operational test and evaluation (OT&E). OT&E included random selection and testing of deployed missiles from those on alert at operational missile wings. OT&E was used to verify the actual performance reliability of the operational missile fleet. A waiver to the EPR warranty was granted in 1988 based on non-cost effectiveness; the waiver covered the warranties for the Stage IV production contract and beyond.

The waiver application reflected a concern about having "little or no opportunity to determine if the missile would perform" successfully, and, further, pointed up the futility of attempting to identify the cause of a failure, should one occur. [3]

Advanced Cruise Missile (ACM). The ACM has been in limited production for three years. The specific EPR warranted is stated as percentage of systems available. Determination of a breach of warranty is based on assessed distribution of the missile's reliability during ground tests. The specific tests are loaded launcher pylon test (LLPT) and system integration test (SIT).

The facts concerning this system are similar to those pertaining to the Peacekeeper Missile Propulsion System. It has been found that flights of the ACM are "too infrequent" to be of much value in enforcing a breach of warranty. Therefore the ACM System Program Office intends to submit a total warranty waiver

application for the latest negotiated lot buy based on non-cost effectiveness. [8]

Advanced Cruise Missile Propulsion System. The specific EPR warranted was defined as a failure rate. However, a full warranty waiver was granted for the system in March 1991. At that time the system was in the production lot II buy. The waiver was justified on the basis that the acceptance testing procedures are sufficient to ensure the quality of the units received. In addition, the waiver application addressed the fact that the dormant nature of the system posed a difficulty in enforcing a warranty breach. [12]

Maverick Missile System. The specific EPR warranty states that ninety-six percent of inspected missiles shall pass an inspection cycle. Visual and functional tests are performed on approved test sets. The missile has been in production for more than twenty years, and, according to the warranty manager, has had an EPR warranty on all units produced, except for low-rate initial production lot. The warranty is not priced separately; the cost is included in the total missile cost. Therefore, a valid cost-effectiveness analysis is not possible in this instance. It is fundamental that the costs and benefits of a warranty must be compared to each other to determine cost-effectiveness.

The missile program has never had a breach of the EPR warranty, and the Program Office is satisfied with the warranty. The contractor recently reduced the failure rate from five percent to four percent, an achievement that program office personnel attribute to the existence of the EPR warranty. Despite the fact that the Maverick Missile Program Office is satisfied with the warranty, there is no way of ensuring that the warranty is cost effective. Nevertheless, the warranty manager revealed no plans to request a waiver of the warranty. [9]

Combined Effects Munitions (CEM) System. The EPR warranty for the CEM states that the function rate of the system will not degrade below a specific percentage. The function rate is defined as the number of units (bomblets) that function from all successful dispenser events divided by the total number of units released from all successful dispenser events minus no-test units. Triennial testing of 30 systems per production lot for the 10-year warranty is the basis for measuring the function rate. The system was produced by two contractors until 1990. In 1990 the system came under a sole-source contract. To date, no warranty claims have been made against the EPR warranty. However, a claim was made against a defective item.

Two views of warranty effectiveness for the CEM can be taken. First, because the system is performing satisfactorily with no failures, the EPR warranty has been effective. The fact that the contractor has produced a system that has not failed suggests that the warranty is working as intended. Second, a warranty has been purchased, but the government is not receiving tangible benefits such as warranty repairs; therefore, the warranty is not cost-effective, because the measurable benefits are zero. These two possible, yet conflicting, interpretations point up the difficulty of justifying warranties for dormant weapon systems.

DOES A GENERAL METHODOLOGY FOR DORMANT WEAPON SYSTEMS EXIST?

The information gathered on the dormant weapon systems discussed above

will now be examined to see how well a warranty on a dormant weapon systems relates to the warranty objectives. Further, the information will be examined to determine whether or not it suggests that a general cost-benefit analysis methodology can be developed for dormant weapon systems. Following is a review of the factors considered in performing the CBAs for the Peacekeeper Missile, the ACM, the ACM Propulsion System, the Maverick Missile, and the CEM.

For warranties, the benefit derived is the cost avoidance to the Government that results from having the contractor perform repair and replacement actions or correct problems at his own expense, plus the cost avoidance from not having to maintain an organic repair shop and train and pay repair technicians. The cost of a warranty is that of buying coverage from the contractor, plus the cost of a system to document, track, and report claims against the warranty. [3]

Peacekeeper Missile CBA. Factors included in the analysis were cost of acquisition, cost of preparing or setting up each item (aircraft, missile, ship, truck, computer, etc.) for operation, cost of routine preventative maintenance, cost of failure repair, cost of spare parts, and the cost of having or contracting a repair shop, including labor. [3] Comparison of life cycle cost with and without warranty was performed.

Advanced Cruise Missile CBA. Factors included in the analysis were reliability assessments, a cumulative availability rate (CAR), the cost of warranty engineering change proposals (ECPs), and the cost of money. The program office applies statistical analysis, including sensitivity analysis, to predict the probability of failures and the consequences thereof. The last CBA performed indicated that one of the contractor's warranties was not cost-effective, and the program office is currently seeking a waiver.

ACM Propulsion System CBA. The CBA for the ACM propulsion system was based on historical data for the system, as well as for the predecessor system. The historical data consisted of the number and types of failures that occurred, and the cost of repair for those failures. The data was used to make an engineering projection for reliability and projected overall failure rates. A sensitivity analysis was performed comparing expected costs and benefits against a worst case scenario in which the benefits would be lower than expected. Non-quantifiable factors such as missile deliveries falling behind schedule were included in the narrative. A comparison of life cycle costs with and without the warranty was made. The last CBA performed indicated the warranty was not cost-effective, and a waiver to the total warranty was obtained in March of 1991.

Maverick Missile System CBA. The Maverick CBA was based on output from The Maverick Cost-of-Ownership Model (MAVCOM). This model calculates all support life cycle costs (cost of ownership) associated with maintaining the inventory of the Maverick missile throughout its operational life. The model allows the performance of sensitivity analyses such as examining the cost differences associated with incorporating an engineering change into production, or with changing an operational or support parameter.

The SPO has never encountered a breach of the EPR warranty, and the warranty is not separately priced. It is questionable that a warranty can be identified as cost-effective if it is not separately

priced. However, the SPO personnel feel that the warranty has provided incentive for the contractor to reduce the failure rate from five percent to four percent (the contract threshold). The missile has been in existence for over twenty years.

Combined Effects Munitions (CEM) CBA. The CBA for the CEM compares the government cost with and without a warranty for the following factors: warranty price, warranty administration, test administration, conduct of testing, and ECPs. The analysis indicated that government costs were higher without a warranty due to the higher cost of test administration and higher cost of conducting tests. Therefore, the purchase of a warranty was determined to be cost-effective. To date, no EPR warranty claims have been made.

CONCLUSIONS

A review of similar dormant weapon systems indicated that a unique attribute of such systems was the use of destructive testing for measuring essential performance requirements. The high cost of destructive testing limited the number of tests performed to ascertain whether or not a system's performance requirements were satisfactorily met. Two of the systems reviewed were granted warranty waivers on the basis of a CBA indicating the warranty was not cost-effective, because the dormant nature of the system limited testing opportunities.

The CBAs for the dormant weapon systems reviewed were examined, and it was found that the general approach taken for all of the CBAs was the use of historical data and projections for future costs versus expected benefits. Sensitivity analysis was performed to varying degrees. Except for the Maverick Missile, all analyses performed also included life cycle cost with and without a warranty. The Maverick Missile CBA appears to be the weakest for the following reasons: 1) it does not compare life cycle cost with and without a warranty, 2) the only cost-benefit sensitivity performed compares a four and five percent failure rate for the EPR warranty, and 3) the cost of the warranty is not known (cost is included in the missile price). The Maverick Missile warranty, however, is the only one that shares risk with the contractor by accepting responsibility for the first four percent of failures. Risk sharing reduces the warranty cost.

Figure 1 illustrates that, for the warranty CBA, the systems reviewed use many different cost categories, and only a few categories are used to measure benefits. Intangible benefits such as increased mission readiness and increased availability were not included in any of the CBAs. The fact that benefits are difficult to define tends to support the GAO's findings that CBAs are inadequate.

Although some similarity exists among the CBAs, the differences in the individual warranties do not suggest a universal methodology can or should be developed. Warranties are tailored to meet the requirements of the specific system, and no two are exactly alike. The remedies specified in each individual warranty determines the factors that should be used to calculate costs and benefits.

Bibliography

1. Air Force Communications Command. Warranty Guide. Scott Air Force Base IL, April 1991.

2. ARINC Research Corporation. CEM Warranty Evaluation. Publication 6000-01-SD-90-ANN-0111. ARINC Incorporated, Annapolis MD, November 1990.

3. Barry, Edward P. Jr., Brigadier General, USAF, Personal Correspondence. Headquarters Ballistic Missile Office (AFSC), Norton AFB CA, 30 Dec 1987.

4. Congressional Quarterly. Pentagon Takes Aim at Arms Warranties Law. Congressional Quarterly Incorporated: 573-576 (10 March 1984).

5. Curtis, Brig. Gen. Lewis E., III. Time for a Relook at Weapon System Warranties: The Shotgun Approach Needs to be Replaced With More Accurate Targeting. Program Manager: 34-37 (July/August 1990).

6. Department of the Air Force. Acquisition Management: Weapon System Warranties. AFR 70-11. Washington: HQ USAF, 1 December 1988.

7. Gebman, J. R. et al. A New View of Weapon System Reliability and Maintainability. R-3604/2-AF. Rand Corporation, January 1989.

8. Palmer, Edward. Advanced Cruise Missile Warranty Manager. Personal Interview. ASD/VCL, Wright-Patterson AFB OH 23 Mar 1992.

9. Pairamore, Etola. Maverick Missile Warranty Manager. Personal Interview. ASD/SD-SL, Wright-Patterson AFB OH, 23 Mar 1992.

10. Stucker, James P. et al. Warranties for Weapons: Theory and Initial Assessment. N -2479-AF. Rand Corporation, April 1987.

11. U.S. Government Accounting Office Report to the Secretary of Defense. DOD Warranties - Effective Administration Systems are Needed to Implement Warranties. GAO/NSLAD-89-57. Washington: Assistant Comptroller General, September 1989.

12. Welch, J. J., Assistant Secretary of the Air Force (Logistics). Approval to Waive Warranty Requirements. SAF/AQ, Washington DC, 9 Mar 1991.

Figure 1: Comparison of Cost-Benefit Analysis Inputs

Costs	Peace-keeper	ACM	ACM Prop.	Maverick	CEM
Acquisition	✓				
Set up for Operation	✓				
Preventative Maint.	✓				
Warranty Cost	✓				✓
Administration		✓	✓		✓
Egineering Change Proposals					✓
Parts		✓			
Materials				✓	
Fuel Leaks		✓			
Cost of Money		✓			
Testing					✓
Essential Performance Requirements			✓		
Design and Manufacturing			✓		
Materials and Workmanship			✓		
Facilities				✓	
Training				✓	
Packing and Shipping				✓	
Technical Manuals				✓	
Support Equipment				✓	
Labor				✓	
Benefits					
Failure Repair	✓	✓	✓	✓	✓
Spare Parts	✓				
Repair Shop	✓				
Test (Analysis of Results)					✓
Good Units					

Systems Identified:

Peacekeeper Missile Propulsion System
Advanced Cruise Missile
Advanced Cruise Missile Propulsion System
Maverick Missile
Combined Effects Munitions System

EVALUATING ACQUISITION PRACTICES: A WINNING STRATEGY

by

Martin I. Kestenbaum, CPCM, Research Fellow, Logistics Management Institute
Ronald L. Straight, DBA, Assistant Professor, Howard University

ABSTRACT

There is a strong mandate within the Federal Government for agency heads to oversee development of their agency's procurement systems and to conduct procurement reviews to ensure those systems meet approved criteria.

Currently, however, there is neither an accepted uniform methodology for conducting reviews nor standards for measuring the quality of an agency's acquisition performance that has been developed for Government-wide application. To meet this need, the Logistics Management Institute (LMI) developed a review methodology incorporating its "best evaluation practices" based on its extensive prior review experience and also inputs from other practitioners.

This paper first briefly describes some historical methods and techniques used in conducting acquisition and purchasing reviews and then addresses some innovative strategies, techniques, methods, and applications developed by the Logistics Management Institute (LMI).

INTRODUCTION

Managers in both the private and public sectors have been vitally interested in ensuring effective purchasing practices in recognition of the critical role that purchasing plays in achieving organizational objectives. Over the past 9 years LMI has had the opportunity to develop and test an acquisition management review methodology at a number of public agencies. The purpose of our reviews is to independently assess the effectiveness and quality of the agency's acquisition process and to provide specific recommendations for improving the acquisition system. Our acquisition review begins with the approval of the Department's budget; continues through the planning, soliciting, evaluating, awarding, and administering processes; and concludes with final contract closeout. Specifically, each review includes the following:

- An examination of acquisition management practices
- An appraisal of the professionalism of the acquisition work force
- An analysis of the organizational placement and structure of the agency's acquisition function
- An assessment of the responsiveness of the acquisition work force to the needs of its customers
- An evaluation of the extent of compliance with laws, regulations, and policies
- An evaluation of acquisition process flow, including automation and innovative technology applications
- An assessment of the adequacy of the acquisition management information system
- An appraisal of the acquisition organization's structural checks and balances.

When engaged by agencies to evaluate their acquisition management practices and recommend improvements, LMI was challenged to develop a review methodology that, although tailored to each agency's unique

requirements and practices, nevertheless provided consistent standards for measuring the quality of the acquisition process and for rating each organization. The methodology enables designated teams to conduct reviews efficiently and cost-effectively, with minimum disruption to the agency under review, while at the same time ensuring that the review produces defensible results.

As we look at the involvement of contracting personnel, project officers, and management in the acquisition process, we place primary emphasis on day-to-day acquisition operations. Using this approach, we have helped offices streamline their acquisition processes to improve quality, timeliness, productivity, and responsiveness to customers.

This article describes our procedures for performing comprehensive acquisition management reviews. In the history section, we highlight the Government-wide requirements mandating such reviews. Then we briefly discuss some of the methods used by others to conduct various types of acquisition reviews. Finally, we describe the review methods and strategies we developed while conducting acquisition reviews at nine different civil agencies.

Some of the innovative methods and applications described include the use of

- Management indicators and contracting benchmarks
- Process flow analysis techniques as a means for assessing the effectiveness of both program offices and contracting offices in carrying out the process
- Interviews for primary data collection and to corroborate and expand on information generated from all primary sources
- Methods for identifying the appropriate size and stratification of the sample on the basis of the contract file universe's size and composition, and for selecting which specific files will be reviewed.
- Questionnaire review checksheets geared to various types of contracts and addressing eight different aspects of the acquisition process (including a scoring method for each)
- An overall scoring methodology for numerically rating the quality of the agency's acquisition operations
- Alternative solutions for correcting deficiencies

HISTORY

Executive Order 12352, "Federal Procurement Reforms," of March 17, 1982 requires that the head of each executive agency

> ...designate a Procurement Executive with agency-wide responsibility to oversee development of procurement systems, evaluate system performance in accordance with approved criteria, enhance career management of the procurement work force, and certify to the agency head that procurement systems meet approved criteria....

In order to aid agency procurement executives in fulfilling their certification responsibilities required by the Executive Order, the Office of Federal Procurement Policy (OFPP) formed a multi-agency team. Its mission was to develop procurement system certification criteria as guidance in evaluating procurement systems. Recognizing the considerable diversity among the agencies, the team developed a comprehensive list of criteria covering most situations, thereby enabling each agency to select the criteria best meeting its unique needs. It was the team's philosophy that no uniform Government-wide set of review standards should be required. As a result, each agency was authorized to apply its own review methodology when certifying the acceptability of its procurement system to its agency head. While we agree that no one set of standards can apply across the board, without *some* uniformity it is difficult to measure an acquisition office's progress over time or to compare its performance with that of other equivalent acquisition organizations. On the other hand, substantial judgment is required in the application of any established standard.

Most available writings on reviews of procurement in the Government sector revolve around studies of major systems acquisitions that have sought to reform DoD's weapon systems acquisition process. Relatively few reports concern results of reviews of individual procurement office operations. However, there is a larger body of relevant literature that applies to the commercial sector; we surveyed it, since the similarities between the Government and commercial sectors have been found to be striking [1]. Later research found that the tasks of the purchasing manager were much the same in both sectors, although their importance differed [2].

Early literature on procurement, from the late 1800s, focused on describing the functions required to be performed and the requisite personal attributes of the individual who would perform them [3]. In 1964, the American Management Association published *Evaluating Purchasing Performance*, which remains useful in describing the issues to be addressed during a review [4]. This work had been preceded by *The Internal Audit and Control of a Purchasing Department* [5]. Since these seminal efforts, a number of studies on methodologies for evaluating the procurement function have been published.

Ammer found that purchasing departments were not being held to the same standards as other corporate departments [6]. Ammer believes that purchasing, like other departments, should be measured quantitatively in relation to corporate objectives. Other authors have proposed different sets of quantitative measures [7, 8, 9]. Raedels, however, cautioned that some quantitative measures, such as cost per order, may not be valid, because efforts to reduce materials costs may increase order-processing costs [10]. Since he found the cost of materials to be the dominant factor in determining the productivity of the materials management function, he looked to a broader measure of total productivity that would relate the total output of goods and services to the total input of resources.

Others have written on the broad issue of which types of measurements should be used. These have included efficiency versus proficiency or effectiveness [11, 12, 13]. Van Weele concluded that the measurement focus will differ, depending on how management looks at purchasing. The focus will be on efficiency if purchasing is seen as a clerical or commercial activity, while it will be on effectiveness if purchasing is viewed as a strategic function of the corporation.

The question of whether purchasing evaluations should be made by an outsider may have been resolved. Several authors recommend that purchasing audits encompassing the entire range of procurement process activities should be conducted by someone impartial [4, 13, 14]. Some authors have also concluded that comparison with other purchasing operations is not the answer – that "the best standard for a purchasing department is its *own past performance*" (original emphasis) [15]. We believe that the answer probably depends on the review's purpose, with the inside review being useful primarily to the head of the purchasing office and the outside review being useful to managers at a higher level, who want to be sure that no conflict of interest affects the results. We also believe that the outside review is most beneficial and that comparisons *can* be made, using judgment to adjust for varying situations.

On the basis of this prior work and of unpublished individual agency review guides with which we were familiar (e.g., those of NASA, GSA, DOE, and DoD), we started performing comprehensive management reviews. After each review, we incorporated into our evolving methodology additional successful techniques used or learned during that review. While we continue to search for more improvements, we consider the techniques discussed here to constitute an established, mature approach to performing comprehensive management reviews of acquisition operations and systems.

REVIEW METHOD

As analysts, our primary aim is to improve acquisition management processes. Our reviews examine acquisition management practices as implemented by contracting officers, project officers, and others involved in the process. In our reviews, we emphasize a

comprehensive, bottom-up operational approach in which we examine the various steps, organizations, and activities required for acquisition, starting with the determination of a need and passing through work-statement preparation, solicitation, evaluation, negotiation, contract award, and administration to contract closeout. We examine all aspects of the acquisition cycle, spending as much effort in reviewing the program and project offices as in reviewing the contracting offices. In this way, we believe we are best able to provide a balanced point of view, to identify areas that need improvement, and to make specific recommendations on fixing the system. Our underlying principle is that management, in order to be able to judge the quality and effectiveness of its acquisition activities, must have (1) accurate knowledge of the workings of the acquisition process and (2) a means of measuring the contribution of each organization involved in acquisition. Figure 1 provides an overview of the comprehensive acquisition review process.

The acquisition cycle begins once it has been determined that a product or service is needed and it ends when the product or service has been delivered and the contract is closed out. We review the entire decision-making process associated with the acquisition cycle, examining both its program and contracting features. This approach allows us to uncover the causes of deficiencies and to identify areas requiring improvement. With this information, we can then provide specific recommendations for corrective actions.

Preparation for Review

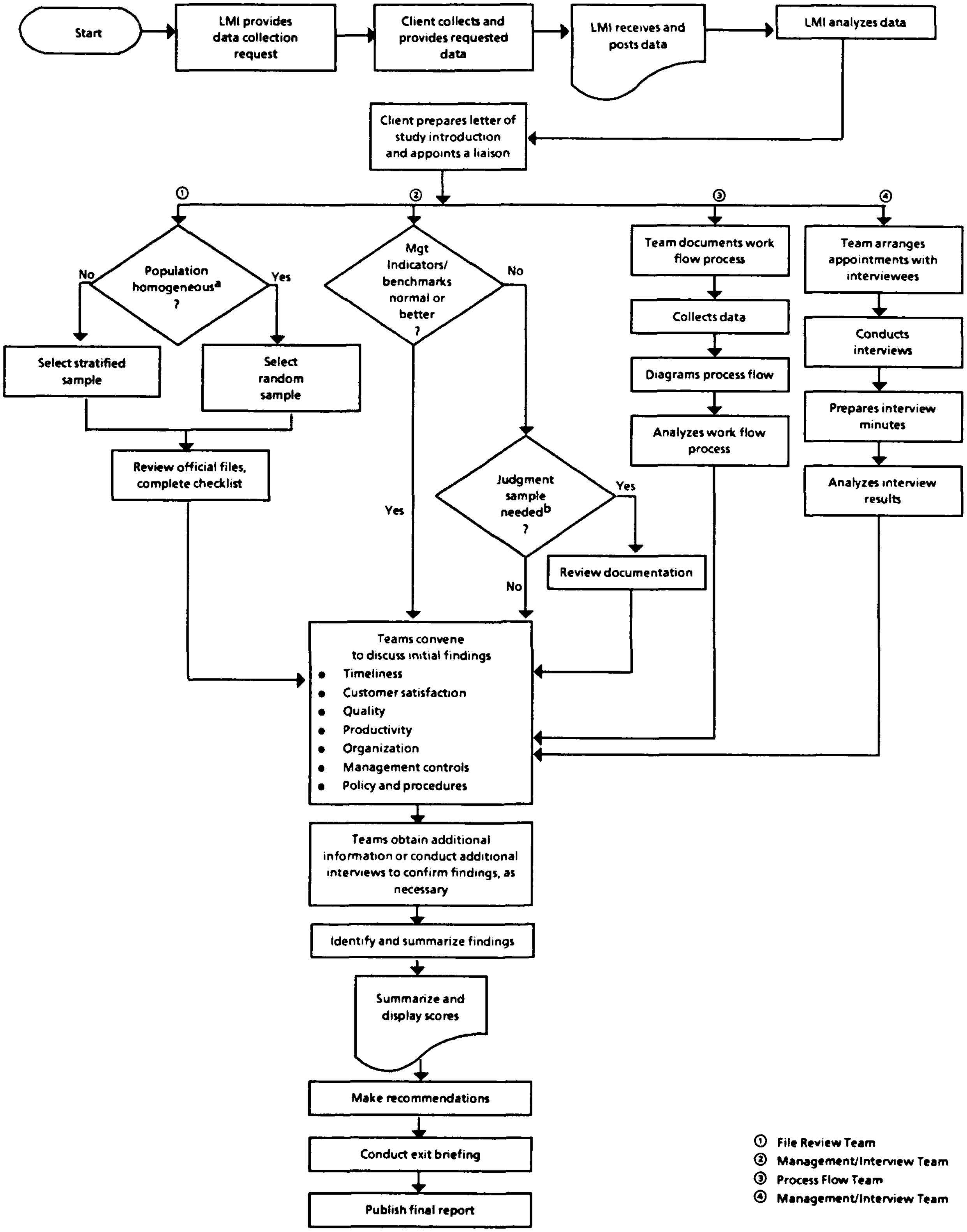
Before starting on-site reviews, we lay the groundwork by requesting that our sponsor arrange a meeting for us with the management representative of the office to be reviewed. Our objective is to have our sponsor introduce LMI and to describe the review's objectives and the need for cooperation. Another objective of the meeting is to address any concerns management may have about the review process.

The review process actually begins in our own offices, well in advance of the start of the on-site review phase. We plan our review strategy and prepare a request for information regarding the agency's acquisition activities. The requested data include preliminary information about the agency's acquisition organization, its staffing, and its management practices and a listing of contracts awarded during the past 2 fiscal years. Some of the data requested are quite specific, such as the number and types of awards obligated each month; socioeconomic goals versus actual experience; number of actions completed but not closed out; a roster of key management, program, acquisition management, and other personnel involved in the award and monitoring process with the organizations to which they belong; the organizational placement and structure of the acquisition organization; and office productivity and timeliness. Other information requested is more general in nature and relates to such areas as management and personnel practices, regulations and policies, and oversight responsibilities.

Organizational Profile

After we receive preliminary data, we begin to develop a profile of the agency's acquisition activities.

We use management indicators and contracting benchmark's predetermined standards to conduct our analysis. Management indicators describe the ability to manage the contracting function and the people in it, rather than the ability to operate the hands-on contracting process itself. Examples include span of control (number of personnel reporting to a single supervisor) and the extent of employee turnover and overtime. Contracting benchmarks, on the other hand, address direct contracting issues. Examples include degree of competition, the number of delinquent deliverables, and the extent of cost growth. By comparing the reported data with the predetermined standards, we can quickly determine whether a given activity falls within an acceptable range of performance. If not, the review team flags that area as one to be specifically followed up on during the on-site review phase. From the roster of personnel, we prepare a preliminary list of people to be interviewed. The list is meant to include a broad cross-section of the individuals and organizations involved in the acquisition



[a] Activity's contracts to be studied are similar to each other.

[b] Special sample review to verify agency problem areas.

FIG. 1. COMPREHENSIVE ACQUISITION REVIEW PROCESS

process – from upper management to supporting personnel.

The On-Site Review – Entrance Interview

Once the preliminary data have been assembled and analyzed, we start the actual on-site review process at the contracting office. First, we arrange an entrance interview with the head of the office being reviewed, or a designee. During this interview, we describe the purpose of our review and our objectives, methods, and strategies. We ask that the interviewees identify any special concerns they may have for the team to review. We request that they prepare a letter to the staff introducing the review team and that they appoint a liaison individual to help obtain data and clear the way for the interviews.

Review Teams

We usually conduct comprehensive reviews using two-person teams. The number of teams depends on the size and complexity of the organization under review. Each team is assigned a different aspect of the review: one team follows the process work flow, another reviews contract files, and a third interviews program/ project officers. The teams work in parallel rather than sequentially. The teams meet frequently to discuss their observations from the preceding day and brainstorm, building a synergy among themselves. They share information and use information furnished by the other teams to initiate new areas of inquiry. The teams confirm the results of each other's investigations. Occasionally we conduct a limited review restricted to examining contract files and conducting some incidental interviews.

The Process Flow Team

The process flow team begins its overall review by summarizing the workload by contract type. Specific contract types are then traced through each step in the acquisition process from budget approval through award, monitoring, and final closeout. In our reviews, we assume that the acquisition cycle begins at the point where it is determined that a product or service is needed. The team begins its analysis by identifying the individuals and organizations involved in each step of the process. Next, the team measures (1) the actual hands-on working hours expended for each process step, and (2) the number of days elapsed from its beginning to its completion. It compares that number with the agency's time standard for completing the step. The team then determines why a specific individual or organization is involved in one or more steps of the process, by identifying the law, regulation, policy, or practice requiring that involvement. Finally, the team attempts to determine the extent to which that involvement adds value, and the additional time required by that involvement.

In most agencies reviewed, we found that neither the process flow steps, nor the related processing times for each step had been documented. As a consequence, it was necessary for us to document the actual steps, and the processing time associated with each. Figure 2 is an example of a small segment of a typical contract process flow diagram. Each step is identified by a separate box. It contains the task number, the start date, its duration in days, a brief description of the activity, the responsible individual or organization, the actual hands-on working hours expended, and the law, regulation, policy, or practice that requires it.

The Contract File Review Team

From the list of contracts provided covering the preceding 2 fiscal years, we select a random or stratified random sample of contracts to be reviewed during our on-site activities. To determine the sample size, the review team considers several factors. The team's goal is to select a sample that is no larger than that required to achieve the accuracy that is needed. It is recognized that, generally, the larger the sample, the more accurately it will reflect the population; but it will also take longer to review and analyze. The team normally selects a sample size that will give them 99 percent confidence that the average sample scores will be within plus or minus .15 of the population average. For example, if the team scores the contract files at 2.45, they can be confident in saying that the average score of all files is between 2.30 and

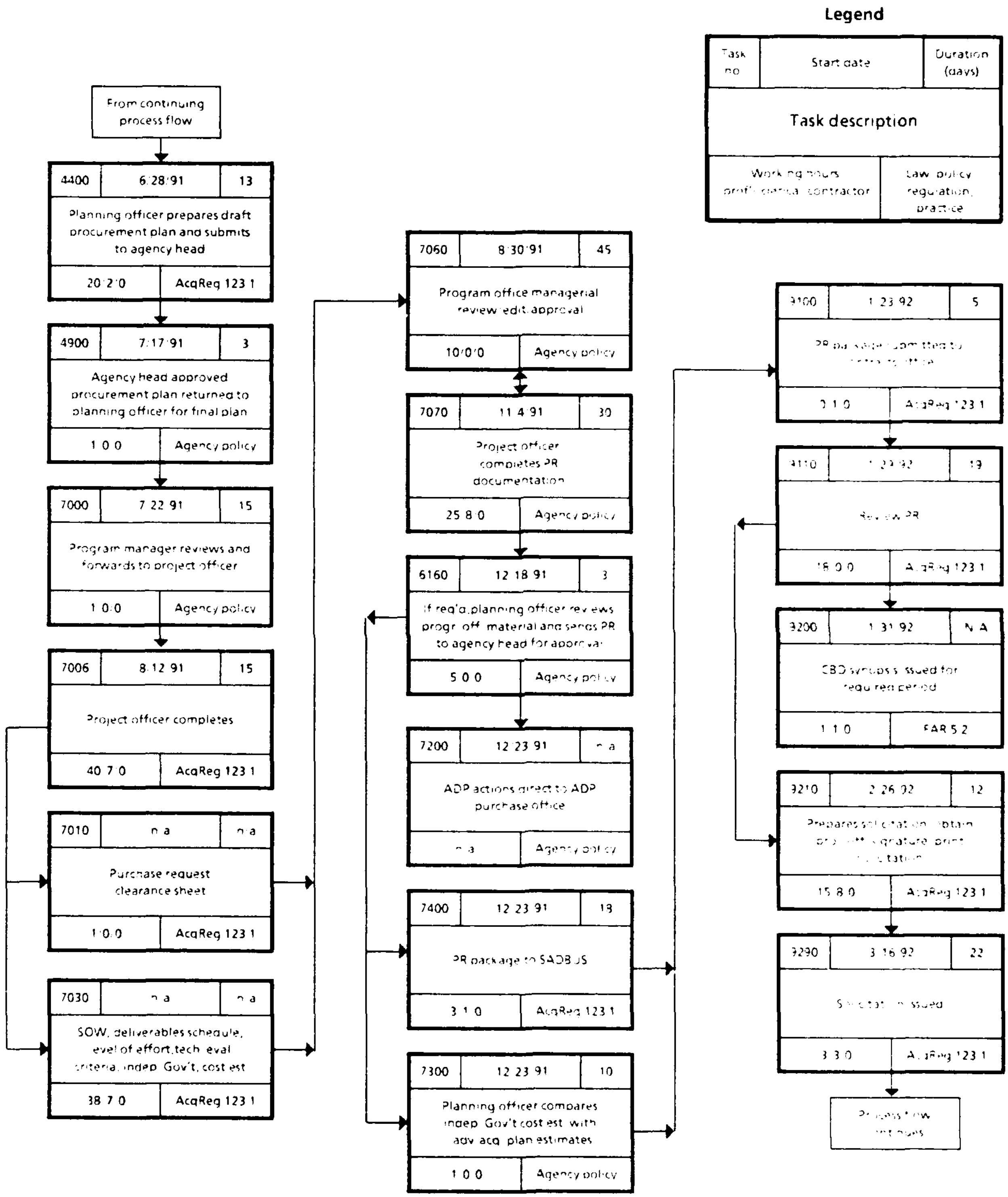


FIG. 2. PORTION OF A TYPICAL CONTRACT PROCESS FLOW DIAGRAM

(Hypothetical)

2.60 (2.45 plus or minus .15). Table 1 shows the necessary sample size to be selected for a given population size.

TABLE 1

DETERMINING SAMPLE SIZE

Population size	Sample size
5	4
10	6
15	8
20	9
30	10
50	12
75	13
100	13
200	14
300+	15

Note: Sample standard deviation assumed to be no greater than 0.2. See Clelland, Richard C., John S. deCani, and Francis E. Brown, *Basic Statistics with Business Applications*, (New York: John Wiley and Sons, Inc.), 1973, p. 323.

The team responsible for reviewing the contract files evaluates and scores the following eight functional areas for each contract reviewed, using a contract file review checklist:

- Advance acquisition planning
- Purchase request
- Solicitation
- Proposal evaluation
- Discussions/negotiations
- Contract award
- Management reviews
- Contract administration.

These eight functional area scores are then summarized, and an overall score for the individual contract file is computed. Exhibit 1 is a contract file review checklist used for advance acquisition planning (for negotiated contracts), one of the eight functional areas. The other seven areas are reflected in similar checklists, each specifically designed for the function being reviewed. Each checklist has two parts. The first part contains questions that must be answered by the team during the review. The second part sets forth a rating scheme to help the reviewers evaluate that functional area.

Once the review of the contract files are complete, the team prepares a scoring matrix in which the eight functional area scores and the overall score for each contract file are posted. Next, an overall average score is computed for each functional area and for the contracts taken as a whole. Each functional area's overall score is then compared with the predetermined standard score of 2.5 to determine the extent to which the acquisition activity meets that standard. For the activity to be considered totally acceptable under our scoring approach, each separate functional area must also meet the standard. Thus, even if the overall score for all contract files reviewed meets or exceeds the standard, but one or more functional area is below standard, a full explanation of the deficiency is presented in our report of findings. We feel it imperative to bring the deficiency to management's attention so that corrective action can be taken. Since we use a statistically random sampling method in selecting files for review, a deficiency noted in our sample is likely to be repeated in all contract files. Table 2 is a matrix that summarizes the contract file review scoring results by individual contract files (identified only by letter and not by name, to preserve confidentiality) and by functional area, computing an overall average score for each. The summary information from this table is then graphically displayed as in Figure 3. While the contract file review may provide only one measurement of the quality of the work performed by the acquisition organization, we weigh it most heavily in our scoring formula because the official files are required to contain the full history of all of the activities

EXHIBIT 1

CONTRACT FILE REVIEW CHECKLIST

ADVANCE ACQUISITION PLANNING (NEGOTIATED CONTRACTS)		
IF NO PLAN DONE AND NONE REQUIRED, GO ON TO NEXT PAGE	YES	NO
ACQUISITION PLAN REQUIRED:	☐	☐
ACQUISITION PLAN PREPARED:	☐	☐
CONTRACTING OFFICE INVOLVED IN ACQUISITION PLANNING:	☐	☐
MILESTONE SCHEDULE IN FILE:	☐	☐
ACQUISITION PLAN CONTENT MEETS REQUIREMENTS:	☐	☐
PLAN SIGNED BY PROJECT OFFICER: DATE______:	☐	☐
PLAN SIGNED BY CONTRACT SPECIALIST: DATE____:	☐	☐
CONTRACTING OFFICER APPROVED ($100,000 TO $1,000,000):	☐	☐
MANAGEMENT APPROVED (OVER $1,000,000):	☐	☐

CONTENT OF PLAN AND QUALITY OF ADVANCE ACQUISITION PLANNING RATING	
	RATING
REQUIRED PLAN NOT DONE OR SERIOUSLY INADEQUATE:	0 TO 1.49
INADEQUATE PLAN OR PREPARED WITHOUT CONTRACT SPECIALIST PARTICIPATION:	1.50 TO 2.49
PLAN MINIMALLY MEETS REGULATORY REQUIREMENTS:	2.50
PLAN EXCEEDS MINIMUM REGULATORY REQUIREMENTS, CONTAINS SIGNIFICANT PROCUREMENT STRATEGY, AND INVOLVES CONTRACTING OFFICE EARLY IN THE PROCESS:	2.51 TO 3.49
PLAN SO SUPERIOR THAT IT CLEARLY CONTRIBUTES TO MISSION ACCOMPLISHMENT, CONSIDERING COST, QUALITY, AND SCHEDULE:	3.50 TO 4.0
RATING ASSIGNED	☐

TABLE 2

SUMMARY OF CONTRACT FILE REVIEW RESULTS

(Hypothetical)

File	Advance acquisition planning	Purchase request	Solicitation	Proposal evaluation	Discussions/ negotiations	Contract award	Management reviews	Contract administration	Total	Avg.
a	2.6	3.0	3.2	2.8	2.6	3.0	3.1	2.0	22.3	2.8
b	1.5	2.1	2.4	1.8	2.0	2.2	2.1	1.5	15.6	2.0
c	n/a	2.4	2.6	2.1	2.3	2.3	2.4	1.8	15.9	2.3
.										
.										
.										
y										
z										
Total	28.5	38.0	41.6	33.5	33.0	37.0	37.5	26.1	275.2	
Avg.	2.0	2.5	2.8	2.2	2.2	2.[illegible]	2.5	1.7		2.3

Note: Rating: 3.50 to 4.00: substantially exceeds standard; 2.51 to 3.49: exceeds standard; 2.50: meets standard; 1.50 to 2.49: below standard; 0 to 1.49: substantially below standard.

related to awarding and administering the contract.

The Interview Team

A major portion of the interview team's time is devoted to assessing the role and effectiveness of both project and contracting officers during the contract award and monitoring process. The project officer is the contracting officer's customer, as the person with the requirement that must be filled. The project officer plays a key role in requirements definition, planning, presolicitation processing, technical evaluation, and contract monitoring. When the review team evaluates the effectiveness of the project officer through the interview process, it uses the analysis prepared by the process flow team, the results of the contract file review, and the results of the evaluation of the management indicators and contracting benchmarks. The following specific points are usually addressed by the interview team:

- Whether the project officer's stated role is being carried out effectively
- Whether required actions are taken in a timely manner and are thoroughly and effectively accomplished
- Whether the project officer is tailoring actions to meet differing individual requirements rather than using a generic approach
- Whether the project officer is notifying the contracting officer of delinquent or unacceptable deliverables in a timely manner
- Whether the project officer is providing the contracting officer regular reports of the contractor's progress, including an assessment of the contractor's progress reports.

The team then interviews representatives of the contracting organization, including contract specialists, contracting officers, cost/price analysts, and supervisors in that

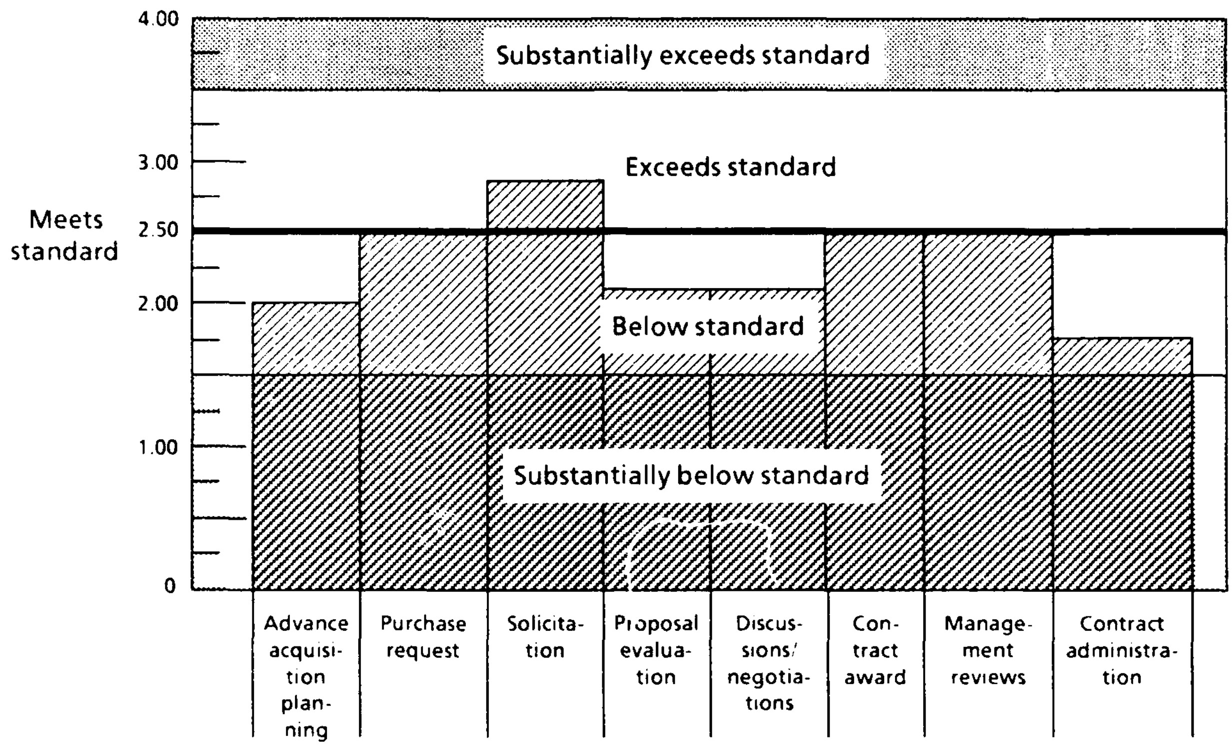


FIG. 3. CONTRACT FILE REVIEW RESULTS

(Hypothetical)

organization. Finally, it interviews others, such as the Small and Disadvantaged Business Utilization Specialist (SADBUS), property administrators, finance officers, quality assurance representatives, legal counsel, inspector general representatives, and the competition advocate. Because each has some involvement in the acquisition process, each has a unique story to tell about the process and how it can be improved.

The interviewers attempt to address the functional areas being rated in the contract file review, the management indicators, and the contracting benchmark areas. The interviews focus on two areas: the knowledge, training, and experience of the interviewee, and the interviewee's specific involvement in the acquisition process. The interviewee is advised that the minutes of the meeting will be used to help highlight operational trends and will remain part of the team's official work papers.

After evaluating each management indicator and contracting benchmark, the interview review team assigns each functional area a descriptive rating. If the functional area appears to be well managed, with the work correctly and effectively performed, then that functional area is usually rated as meeting the standard. Ratings above or below standard are assigned where strengths predominate or where the need for improvement merits serious consideration. Exhibit 2 is a hypothetical completed management indicators worksheet, while Figure 3 is a completed hypothetical contracting benchmarks worksheet. In evaluating each factor, the team uses multiple sources of information. The primary information sources are

- Responses to the initial request for data
- Responses to the contracting activity profile
- Responses to questions posed during the interview phase

- Examination of supporting documentation
- Interaction with contract file review and process flow team members.

Each team member prepares a two-part written justification to support the rating selected. The first part contains essential background (i.e., a summary description of the characteristics and importance of the topic to be rated, and the requirements or factors considered in the rating, including regulatory ones). The second part normally includes observations and discoveries made during the review, discussions of any particularly notable attributes or practices leading to ratings above or below standard, and any other explanations necessary to provide insight concerning the assigned rating. As a final check on the ratings assigned, at the conclusion of the process the responsible team member presents an oral defense of each rating to the entire review team. Any additional pertinent information developed by members of the contract file review or process flow teams is factored into the ratings at that time. Once the ratings and supporting documentation are agreed to by the entire team, the narrative descriptions are then converted to numeric equivalents for ease of presentation. A numeric scale of 0 to 4.0 is used, with 4.0 being the highest score and 2.5 considered the standard score. (See Figure 3)

The information gathered during the interview process helps to confirm the results of the findings from the contract file review and process flow teams. However, there is no separate numeric scoring assigned for program or project management activities. Any areas requiring improvement are addressed in narrative fashion in the final report.

THE FINAL REPORT

Upon completion of the review, the entire review team develops a final overall numeric rating for each functional area. In arriving at these numeric ratings, the review team converts the narrative description to numeric equivalents for ease of presentation. Finally, the team merges the management indicators, contracting benchmarks, and contract file review scores to develop an overall rating for the acquisition organization.

We present the office head with an oral briefing of our findings at the conclusion of our review. We indicate at that time though the organization's overall average may meet or exceed the standard, functional areas falling below this standard will be addressed in the final report. Subsequently, our sponsor sends the office head a copy of the final report and, if there are areas requiring improvement, requests that a corrective action plan be submitted along with an implementation schedule.

SUMMARY

LMI uses the strategies described in this article to conduct its comprehensive acquisition management reviews. By using a structured review methodology, we have found that teams conduct their reviews in a consistent manner from organization to organization. Our method helps agency internal review teams in the same way. This consistency ensures fairness and enables the identification of common problems in agencies. Therefore, we are in a unique position to identify common trends based on our findings.

We also believe that our reviews get to the heart of an organization's problems quickly. This becomes particularly true when management uses the process flow analysis to compare program officers' involvement and contributions in the preaward and postaward acquisition phases with the involvement and contributions of the contract management organization. When upper management is provided a review based on a scoring methodology, it has a quantified basis for judging the effectiveness with which its acquisition operations are being conducted.

REFERENCES

[1] Sheth, Jagdish N., Robert F. Williams, and Richard M. Hill. "Government and Business Purchasing: How Similar are They?" *Journal of Purchasing and Materials Management*. Vol. 19 (Winter 1983), No. 4, pp. 7 – 13.

[2] Muller, Eugene W. "An Analysis of the Purchasing Manager's Position in Private, Public, and Nonprofit Settings." *International Journal of Purchasing and Materials Management.* Vol. 27 (Fall 1991), No. 4, pp. 16 – 23.

[3] Fearon, Harold E. "Historical Evolution of the Purchasing Function." *Journal of Purchasing and Materials Management.* Vol. 25 (Spring 1989), No. 1, pp. 71 – 81. (Reprint from February 1968).

[4] Hayes, F. A. and G. A. Renard. *Evaluating Purchasing Performance.* New York: American Management Association. 1964.

[5] _____, 1955. "Internal Audit and Control of a Purchasing Department." Research Committee Report No. 2. The Institute of Internal Auditors. New York.

[6] Ammer, Dean S. "Is Your Purchasing Department a Good Buy?" *Harvard Business Review.* (March – April 1974), pp. 36 – 159.

[7] Janson, Robert L.. "Graphic Indicators of Operations." *Harvard Business Review.* 1980.

[8] Janson, R. L.. "Statistical Management of Purchasing." *Purchasing World.* August 1989.

[9] Croell, Richard C. "Measuring Purchasing Effectiveness." *Journal of Purchasing and Materials Management.* Spring 1977.

[10] Raedels, Alan R. "Measuring Productivity of Materials Management." *Journal of Purchasing and Materials Management*, Vol. 19 (Summer 1983), No. 2, pp. 12 – 18.

[11] Felch, R. Bruce, and Robert I. Felch. "Controlling Purchasing Price Performance." *Journal of Purchasing and Materials Management.* Vol. 24 (Fall 1988), No. 3, pp. 36 – 39.

[12] Van weele, Arjan J. "Purchasing Performance Measurement and Evaluation." *Journal of Purchasing and Materials Management.* Vol. 20 (Fall 1984), No. 3, pp. 16 – 22.

[13] Speckman, R. E. "The Purchasing Audit: A Guide for Management." *Journal of Purchasing and Materials Management.* Fall 1979.

[14] Lewis, H. T. "Evaluating Departmental Efficiency." *Harvard Business Review.* (May 1948), pp. 313 – 28.

[15] Pooler, Victor. "Measuring the Purchasing Man: Trend." *Journal of Purchasing.* (November 1973).

FROM BUDGET TO AWARD: ACQUISITION PROCESS FLOW ANALYSIS

by

Martin I. Kestenbaum, CPCM, Research Fellow, Logistics Management Institute
William J. Hooker, Ph.D., Consultant, Logistics Management Institute
Ronald L. Straight, DBA, Assistant Professor, Howard University

ABSTRACT

Toward the end of the fourth quarter, the contracting offices in many Federal agencies undertake frantic efforts to obligate their fiscal-year funds before year-end. This scramble, which may result in higher processing cost and lower quality in the award process, often leads to an erroneous perception by higher agency management that the failure to space workload evenly throughout the fiscal year is attributable primarily to poor planning and/or execution by the contracting office staff. Over the years, this perception has led to the commissioning of a number of high-level studies that have focused primarily on the contract award function rather than looking at the acquisition process as a whole.

We studied the overall acquisition systems at several agencies and found the primary cause of late fourth quarter contract awards to be the failure of program offices to submit completed procurement requests to contracting offices in a timely manner. While program officers often excuse their delinquency by blaming Congress for failing to appropriate funds in a timely fashion, we generally found this argument to be without merit, since the planning process can actually start well before funds are appropriated.

To better understand the linkage between planning, budgeting, and project implementation, and to develop a basis for streamlining and simplifying the acquisition process, we applied a process flow analysis tool. This tool provides for charting the steps in the process; identifies the law, regulation, policy, or practice requiring each step, the start date and actual elapsed time for that step, and the actual professional and support hands-on hours expended for completing it. Visual display is achieved by using commercial PC software for on-screen and hardcopy printout.

The process flow analysis tool enables managers at all levels to view the entire spectrum of the acquisition process, identify impediments and excessive or unnecessary steps, and fix organizational responsibility. This paper describes the methodology we used to develop the tool and tells how we applied it to the acquisition process at a number of agencies.

INTRODUCTION

The country will no longer be doing business as usual. After 12 years of Republican control of the executive branch, the reins have now been turned over to a Democratic Administration. This event coupled with the existence of a Democratic majority in both houses of Congress, makes massive change possible at every level of the Federal Government and creates the opportunity for the new Cabinet Secretaries and other political appointees to reshape their departments, as needed, to carry out their programs

Most of the appointees are new to the departments they will be responsible for directing and are thus unfamiliar with the departments' inner workings. They will quickly discover that, in many of those departments, much of their mission is carried out by the private sector through contracts (or grants) despite the thousands of employees on the payroll. They will also find that much of the

work done by the Federal bureaucracy, consists of preparing budgets to support the Administration's programs, preparing the various documents necessary to award contracts, and monitoring progress to assure that the purpose of the contract is actually fulfilled.

While these may not appear to be very daunting tasks, the reality is that accomplishing the award and monitoring of a contract is a complex, time-consuming, too often frustrating exercise that requires real skill and considerable knowledge of the department's internal operations, the steps and players involved, and of the vast body of statutes, regulations, policies, and practices governing the process. "Contracting [out of services] is one of the most difficult methods a public organization can choose, because writing and monitoring contracts require so much skill. Many governments act as if their job is done once they have signed a contract."[1]

Any manager faced with the task of implementing programs through contracts has a responsibility to ensure that the awarding and monitoring process is handled in an effective, efficient, and timely manner while complying with the applicable rules. What management tools can the executive use that will quickly provide a full understanding of what is going on, to enable him or her to identify opportunities for improving the process? One such tool is a detailed process flow diagram. This paper discusses its usefulness for controlling that part of the overall acquisition process that begins with budget formulation and continues through to contract award. The techniques we describe can be applied to other administrative procedures as well.

There is a tremendous interest at all levels of society in the provision of "good Government." In the hope of ensuring efficiency in the provision of services, reform efforts at the turn of the century focused on financial accountability. The need for efficiency continues. However, the Logistics Management Institute (LMI) has found that Government organizations seldom document their work process flows. The result is that information vital to the people who must work with or evaluate the organization's operations is not available. In particular, we have reviewed several activities' acquisition operations, none of which has had documented process flow diagrams. Instead, the organizations have been relying on their staffs to use their memories to handle the next acquisition "just like they did the last one."

We recommend having process flow documentation for several reasons. An individual new to the organization will be able to use it as a guide to learning how the organization functions. Managers can review sequencing of steps, the desirability of concurrent as opposed to sequential steps, the value added by each step, and the timeliness of the process. Process improvement teams will be able to use it to identify targets for review (current total quality management and similar initiatives must use the existing process flow as the baseline for continuous improvement).

The documentation provides managers and staff a mechanism for analyzing and implementing the acquisition process to improve its quality, timeliness, responsiveness, effectiveness, and efficiency. This paper provides an introduction to the development and use of process flow diagrams and their analysis in the acquisition environment, focusing on moderately sized contracting activities conducting routine types of actions.

HISTORY

The systematic study of process management is usually included as part of the basic college curriculum in production, with its methods being applied to the production of various types of industrial goods. Typically, the main distinction in process flow from organization to organization is whether the production operation is conducted using continuous process flow or job order shop manufacturing techniques. Line balancing and other shoploading, scheduling, and sequencing problems are all commonly addressed by using various process management models, which can also be used for controlling the administrative processes.

Most administrative systems are characterized by a mode of operations in which work flows in serial fashion from one process to

another. In describing this type of processing, Starr notes that (1) flow shop facilities tend to use special-purpose equipment, well designed to deliver the high volume of output needed and that (2) serial production encourages division of labor efficiencies in accord with specialization (also, there are economies-of-scale advantages).[2] While using special-purpose equipment may not be applicable for processing contract actions, conceptually such equipment serves as a useful model by suggesting that contracting staffs need also to be highly specialized to accomplish their mission.

Too often, when a problem is identified, a "patch" is applied to fix that individual problem. A series of patch fixes can soon produce a poorly operating process. A broader approach is needed. Starr notes that one the main dangers we face is the unwarranted treatment of problems in false isolation. "Success in the design phase prohibits fractionation, segmentation, or splintering the system."[2] Looking at the entire process flow avoids such problems.

As previously noted, near the turn of the century, a number of public administration reform efforts were designed to better enforce accountability. Stemming from those efforts, a variety of methods of assessing accountability and providing information for decisionmaking have been applied within the government. These include management by objectives, performance budgeting, operations research, compliance and performance auditing, program evaluation, cost accounting, financial analysis, and citizen surveys.[3] A current requirement is the application of continuous process improvement or other total quality management (TQM) techniques in Federal Government activities.

An example of this requirement is contained in Executive Order 12637, dated April 28, 1988, *Productivity Improvement Program for the Federal Government*. It called upon Federal Agencies to improve productivity by 3 percent annually. While formal Federal productivity planning and reporting have been discontinued, Congress has mandated reporting requirements that cover many of the same matters.[4]

Within the Government, an effort has been made to incorporate the techniques of process flow into the provision of public services. They are often incorporated in TQM programs as a part of work process improvement efforts. "Processes are 'systems' brought into existence to produce results based on requirements of the customer. The systems nature of work processes implies an input/output structure where processing contains a series of value added steps. Inputs are generally received from suppliers and outputs go to customers."[5]

Process flow techniques have been adapted for use in business applications. For instance, one of the areas captivating many managers today is the use of business reengineering techniques leading to simplification, streamlining, and organizational redirection. The starting point for business reengineering is charting the existing process flow, a necessity before any reasonable systems analysis can begin.[6]

Another major impetus for process flow charting and analysis within the Federal Government results from the Chief Financial Officers (CFO) Act of 1990 and from its implementation by the Office of Management and Budget (OMB).[7] The CFO Act applies to fourteen Federal departments and nine major agencies. Simply stated, it mandates that (1) agencies develop a methodology for measuring performance of their operations by using organizational efficiency and effectiveness performance indicators and that (2) program outcomes be incorporated into annual financial statements for revolving and trust fund activities. These requirements are implemented through various OMB and DoD references.

In response to congressional and OMB direction, the DoD Comptroller issued a memorandum on October 29, 1992, to the Service Secretaries and agency heads entitled "Performance Budgeting." It says that the principal purpose of performance measures is to gauge progress against stated goals and objectives. Other uses of performance measures, including resource allocation; management; and serving as a basis for individual and

organizational assessment, recognition, and rewards are also set forth.

The Comptroller identifies the three major categories of performance measures as factor of production indicators, outcome indicators, and work process indicators:

- Factor of production performance indicators include input measures relating to efficiency. Efficiency measures include unit cost per output, work measurement (labor input), and cycle time. Effectiveness measures may include quantity, timeliness, quality, or customer satisfaction.

- By using impact measures, outcome indicators try to determine direct results achieved.

- "Work process indicators are measurements of the way work gets done in producing the output; this includes cost-effectiveness. Efficiency Reviews or Management Analysis are basic industrial engineering-based approaches which flow chart the existing work processes and subprocesses. Efficiency reviews achieve average savings of 10 to 15 percent while competition (A-76, etc.) produces savings of 20 to 30 percent. These reviews usually make limited changes in work processes."[8]

REVIEW METHODOLOGY

For the purposes of this paper, we are primarily concerned with work process indicators. These are indicators of the way work is accomplished to produce the output, given a certain level of resources, efficiency, and effectiveness. The Comptroller describes process flow charting as one management tool used in conjunction with work process measurements, as follows:

> Flow Charting is a work process evaluation tool that graphically maps the activities that make up a process. It illustrates how different elements and tasks and subtasks fit together. It is an effective discipline to identify all tasks and activities in a work process and the associated resources (particularly time) associated with those tasks and activities. Flow charts can be designed to describe a business process, a functional process, and the physical flow over space and time, all of which provide insight about efficiency and effectiveness opportunities. Flow charting deserves separate mention because it is a basic analysis tool used in management analysis, theory of constraints, cost-based activity modeling and other work process evaluation techniques.[8]

LMI uses process flow documentation and analysis as one of its evaluation tools when reviewing acquisition management practices. This tool enables us to look across the entire spectrum of an agency's acquisition process and track the interaction among the budgeting, planning, program, and awarding offices that leads to specific contract actions. It enables us to identify (1) reasons for processing time delays or uneven workload at any point along the acquisition path, (2) the responsible organization, (3) impediments and bottlenecks, and (4) excessive or unnecessary processing steps. Thus we can establish organizational responsibility for successes as well as failures of the acquisition system.

In our experience, process flow studies are best accomplished by a team of two people, at least one of whom is knowledgeable about the process being studied. This arrangement allows the team to document a set of generally understood steps for the process, so that managers, new employees, evaluators, and others can rapidly understand the overall requirements of the effort and the typical output requirements at any point in the process. In our reviews, we start by examining budget formulation and its linkage to acquisition and continue through planning and program office activities to conclude with contract award.

Several different planning processes take place (e.g., program planning in support of budget formulation, project planning in support of the funding allocation process, and acquisition planning, leading to the award of a specific contract). For the purposes of this paper, we focus on the acquisition planning process, describing the means by which the

project and contracting offices work together to process a contract for a specific project.

In our reviews, the acquisition cycle begins with the generation (by program office personnel) of inputs to the annual advance acquisition plan, which is intended to encompass all the projects of the office. The cycle progresses through various planning, program, and contract office tasks until final closeout. In the course of our reviews, we have not seen any evidence of detailed project acquisition documentation being provided to support the budget formulation process. Indeed, detailed project acquisition documentation generally begins to appear only after the congressional budget implementation process is well under way, approximately 13 months after the start of the budget cycle.

Figure 1 presents the typical steps taken by LMI leading to the documentation and analysis of the process flow. A description of these steps follows.

The process flow team begins its review by conducting preliminary research on the requesting component's organizational structure, budgets, program types, Inspector General/General Accounting Office findings and recommendations, and any other significant published material. This research enables the team to selectively package process flow documentation from its prior studies bearing the greatest overall relevance to the new component, as an initial baseline.

Initial presentations and discussions are conducted with personnel at the organizational levels deemed appropriate by the requestor – departmental, divisional, agency and, ultimately, bureau and/or branch – to establish ground rules and goals for the review. We emphasize at this stage that the end products of the review will be composites of the data provided by the individual staff members participating in the review, and that the process flow team will maintain the confidentiality of personal responses.

At subsequent working group meetings, the specific contract actions that will be the subject of the review are identified, as are the organizational personnel who will participate. These personnel gather available process flow or other documentation describing their

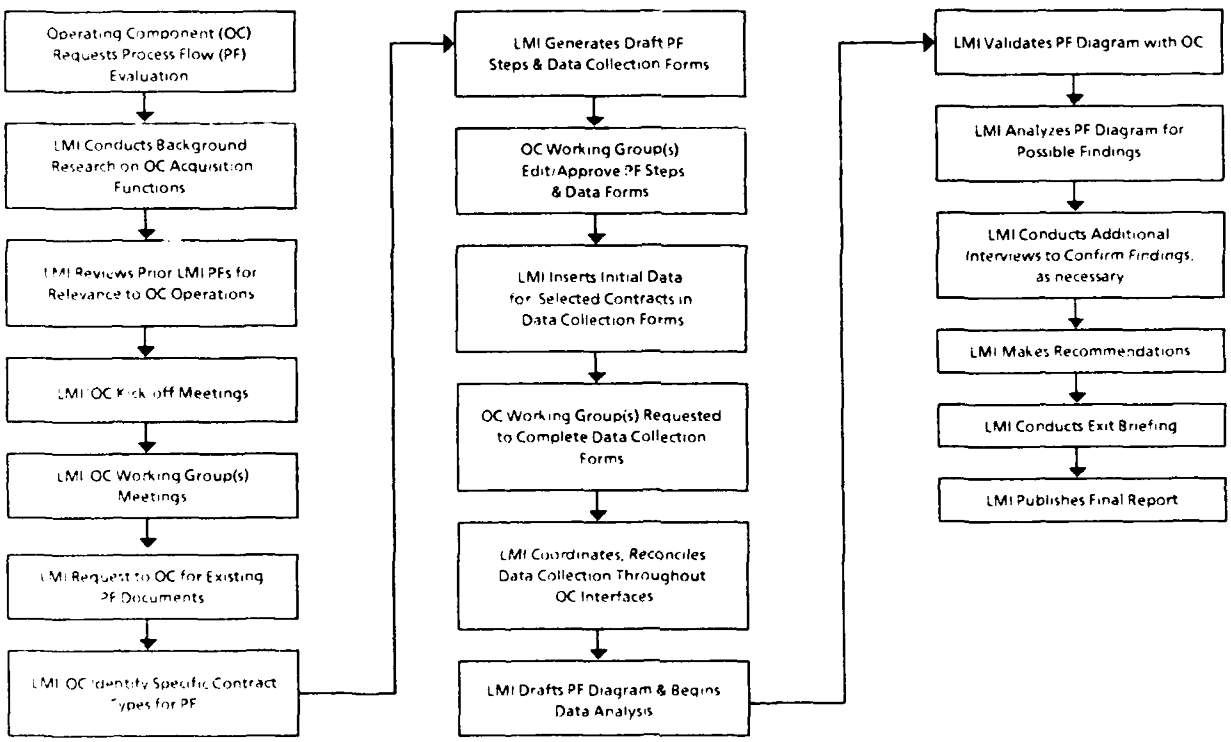


FIG. 1. PROCESS FLOW DOCUMENTATION STEPS

procedures for the budgeting, planning, programming, and contract award phases for study by the process flow team. From these documents, the process flow team generates first drafts of the suggested process flow steps and data collection forms and submits them to the organizational personnel for final draft edit.

The process flow team then summarizes the organization's contracting workload by contract purpose (e.g., services, major systems, evaluations) and by type (e.g., fixed-price, cost-plus-fixed-fee, or incentive). Only those contract types having a large number of actions and high dollar volume are usually selected as our representative sample. Contracting types having only a relatively few examples are generally avoided, since the sample size would be too small to be representative. (For example, contract actions that might be included in a process flow analysis could be competitive solicitations for negotiated services with a price between $100,000 and $500,000 that result in cost-plus-fixed-fee, single-award contracts.)

In the various agencies that we reviewed, we found that no documented acquisition process flow diagram existed prior to our efforts to develop one. In some offices, process flow steps unique to that individual office had been partially documented or could be determined from intra-office memoranda. However most often the only record of the process flow steps was in the memory of the participants, particularly for steps at the interface between components. In no case was the elapsed time for completing each step identified, nor had the average level of applied professional effort been determined.

Because of this recurring situation, we generally begin by briefly describing to the participants the process flow steps that we have previously developed at other agencies considered to be functionally similar to the agency being reviewed. The candidate process flow diagram lists the description of each step considered relevant to the agency being reviewed. In this initial discussion, no reference is made to specific contract actions or their timing; rather, the focus is on the flow itself and on developing meaningful descriptions for each step.

After we have developed what we consider to be an accurate listing of processing steps, we prepare a data collection form to help in obtaining basic information regarding each step. Figure 2, shown on the following page, is an example of this form. The form has a place for recording information about the sample contract selected and for describing its basic characteristics. The steps – or milestone events – are listed. The participants are requested to complete the form after LMI has filled in some initial data. For each contract in the sample, we require such information as the start date and end date for each processing step; the actual hands-on processing time for that step; and the reference to the law, regulation, policy, or practice requiring the step. ("Practice" usually applies when nobody seems to know where the requirement came from, other than "we've always done it that way.") The hands-on processing time includes the professional, clerical, and contractor support hours actually expended to complete that step.

The primary standard process flow symbol that we use is the activity indicator, represented by a rectangle with a brief description of the activity enclosed. Figure 3 contains an enlargement of the activity indicator descriptive legend.

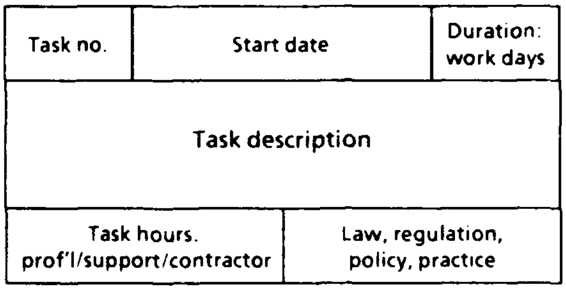


FIG. 3. EXPANDED ACTIVITY BLOCK

The example in Figure 3 when filled in includes such information as the start date, the step's duration in work days, hands-on processing time, and the reference mandating the step. In addition, it includes an alpha-numeric descriptor for ease in identifying a

CONTRACT NO. _______ FY___ This form is being used to validate the attached Baseline Process Flow Diagram and has been partially completed. Please make corrections/additions as necessary.

CONTRACT DESCRIPTION

Type: _________ Value Obligated: $_________ New Effort: Y N New Contract to Follow Expiring Contract: Y N Services: Y N

Modification to Exercise Option Under Existing Contract: Y N Supplement to Existing Contract: Y N

Extent of Competition: ______Full and Open ______Small Business Set-Aside ______8(a) ______Other (________________)

Project Officer's Name: ____________________ Program Office: ____________________

EVENT	DURATION		RESOURCES			DRIVER
	Time in office					
Milestone title[a]	Start date	End date	Professional staff hours	Support staff hours	Support contractor hours	Law, regulation, policy, practice[b]
9100: PR Package Submitted to Contracting Office						
9110: Review PR						
9200: CBD Synopsis Issued for Required Period						
9210: Prepare RFP, Proj. Off. Signature, Print RFP						
9290: RFP Issued						
9300: RFP Closed						
9400: Proposal Evaluation						
9420. Evaluation of Bus. Props; Cost/Price Analysis						
9430. Competitive Range Determination						
9440: Establish Pre Negotiation Objectives						
9500. Disc's/Neg's with Offerors; BAFO if Req'd						

Note: YN: Yes/No; PR: Procurement Request; CBD: Commerce Business Daily; RFP: Request for Proposal; BAFO: Best and Final Offer.

[a] Please indicate any additional, or intermediate, milestones. Skip any tha do not apply to your office.

[b] Please identify laws, regulations, policies, and practices that require each step.

FIG. 2. DATA COLLECTION FORM (PARTIAL)

specific step. Since the standard process flow diagraming symbols do not lend themselves to depicting acquisition process flow data, we normally use only the expanded activity indicator.

While some of the required information may be available from contract files, considerable time is usually expended during the interviews in collecting data often retained only in the memories of the participants. We emphasize to the participants that it is to be expected that the elapsed "duration" time will exceed the actual hands-on processing time ("task hours") because there will be some "wait" time. On the other hand, excessive elapsed time may be an indicator of omitted steps and may signal a need for inserting additional steps in the process flow.

After collecting data sheets for each contract in the sample, we summarize the individual actions into a representative time-dependent process flow diagram for that type of contract action. Figure 4 is a hypothetical example of a portion of a typical contract process flow diagram. For some events, actions occur simultaneously for all contracts (e.g., issuance of the planning document.) However, beginning with the preparation of the purchase request (PR) and its submission to the contracting office, each purchase request is treated as a separate contract action, and the date of receipt of each in the contracting office is individually logged. In most cases, the process flow diagram shows the median start time (i.e., one-half of the cases started earlier and one-half later) as the key characteristic.

In a few instances, where it seems sensible to do so, we also show a range of times for various sample items on the diagram by using a shaded area to the left and to the right of the activity block. In that case, the left end would show the date the first sample item passed through that activity and the right end would show the date for the last item in the sample. The median time, with the other information for the step, is still shown in the activity block within the shaded area.

When the complete process flow has been diagramed, the people who provided information are asked once again to review the diagram to be sure that it accurately represents the actual process. Once its accuracy is validated, the diagram provides the basis for analysis and streamlining.

ANALYZING THE OPERATION USING PROCESS FLOW TECHNIQUES

One of the immediate results of generating a flow diagram is that the participants in the process can see how it actually works as opposed to how they thought it worked. For managers somewhat removed from day-to-day operations, the differences may be especially revealing. For this reason, the diagram is an invaluable tool for analyzing and streamlining the process, particularly where inter-divisional chains of responsibility are involved. "There are several methods for prioritizing work processes in order to identify those in which improvements can have the greatest impact."[5] Some of these methods are matrix analysis, the prioritization grid, or a pareto diagram.

In one organization, the process flow diagram showed a long period of program/project office inactivity preceding the initiation of the planning process for the next fiscal year's contracting activities. The organization's explanation was that no planning is undertaken until an official memorandum from headquarters is received requesting that planning begin. We found no reason why the program or project office shouldn't start earlier, in anticipation of receipt of the memorandum, especially since the memorandum is usually issued later than scheduled. The harm caused by headquarter's lateness in issuing the memorandum and by the program office's waiting for it was not realized until the process flow diagram highlighted the adverse impact.

Where time standards have been developed for steps in the award cycle, as is frequently the case in the contracting office, the team can compare the actual process time with the time standard for completing a specific step. It can also determine whether unplanned delivery of upstream documents (such as purchase requests) inhibits the achievement of uniformity in workload throughout the year. By analyzing the process

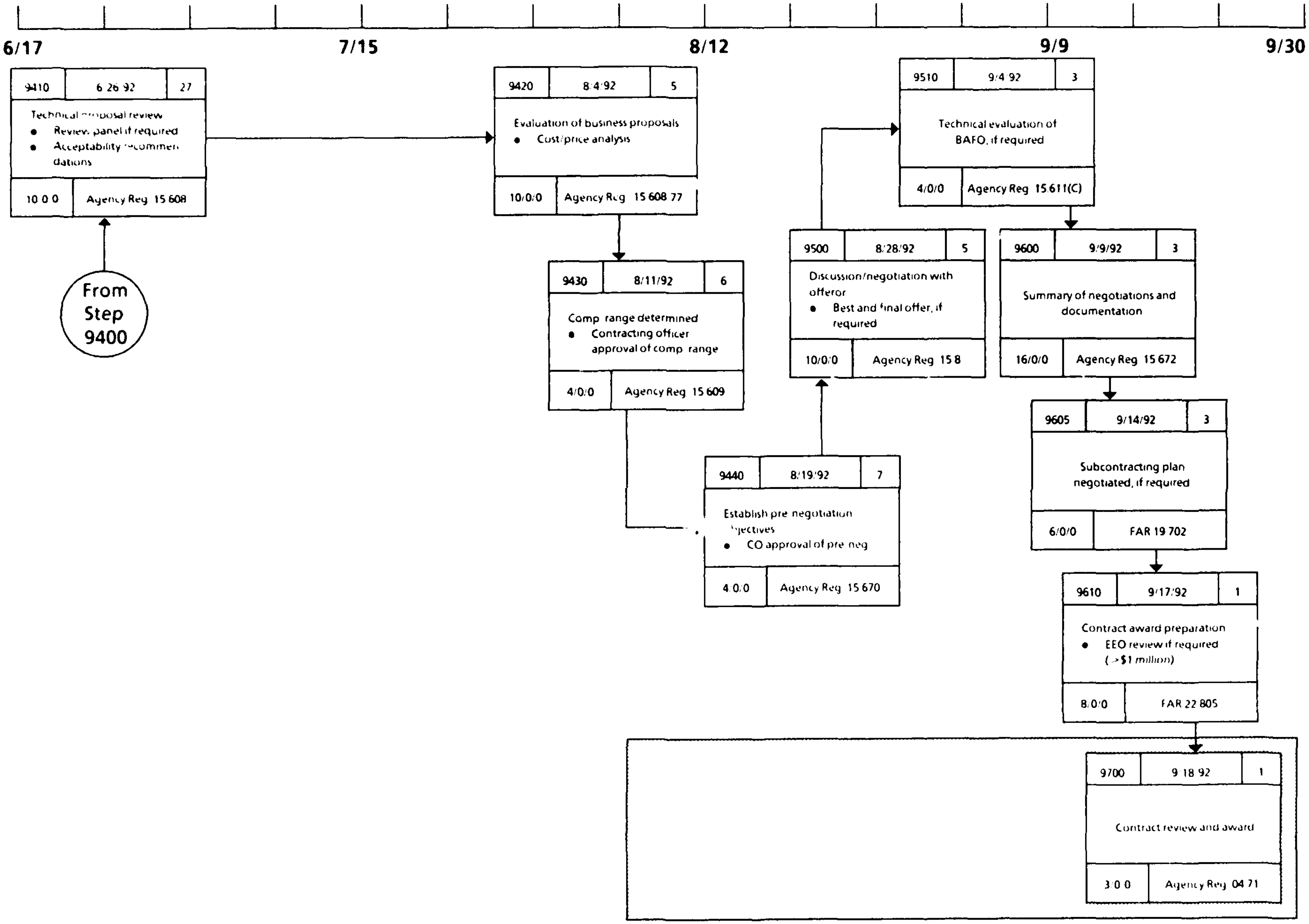


FIG. 4. CONTRACT PROCESS FLOW DIAGRAM
(HYPOTHETICAL)

flow diagram – and by identifying the law, regulation, policy, or practice mandating various steps – the team can determine why a specific individual or organization is involved in one or more steps. It can also start the streamlining process by identifying steps that are being performed sequentially when it would be more efficient to perform them concurrently.

Finally, the team may determine the extent to which a step adds value, the nature of the value added, and the additional administrative time it requires. A key question that may be asked in determining the value of a process step is: How much extra would a customer pay to have that step included, on the basis of its benefit to the overall process?[5]

If the step does not add value from the customer's point of view, it should be eliminated if possible. The need for proper identification of the specific customer for each step in the process is an important element in process flow analysis. However, a step required by law (e.g., synopsizing in the *Commerce Business Daily*) may be of value to the general public but be little appreciated by a specific project officer. Identification of not only the customer, but of the customer's requirements is an essential ingredient of process flow analysis, but some steps must be carried out regardless of whether customers believe they add value.

A difficult requirement of good management is the need to establish measurements, such as processing time standards, that can reasonably be applied during the routine of working through the process. The process flow diagram is helpful for identifying where such measurements should be applied. It may be used to highlight natural "gates" that can be used as measurement points, or it can suggest other convenient measures to monitor performance.

From this information, we are then in a position to determine which steps can and should be modified, consolidated, or eliminated.

Once process flow steps have been documented at several different organizations for the same function (e.g., acquisition processing), it becomes clear that many of the steps are similar, particularly when viewed at higher levels of aggregation. On the basis of this observation, it is then possible to identify the best practice applicable to each step included in the general process flow diagrams, which now can be used to develop a "best practices" model. Organizations can then compare their own process flow diagrams to the "best practices" model and evaluate the value added by various steps, some of which may be different from those in the model. Such comparisons may also result in revising the "best practices" model.

ONGOING INITIATIVES REQUIRING PROCESS FLOW DIAGRAMS

Among ongoing initiatives that depend heavily on the use of documented process flow diagrams, we take note of three. First, such diagrams are a basic step in efforts to improve quality, whether known as TQM, as Quality Improvement, or by some other name. These efforts are well documented in the literature and need only be mentioned here. The second is the DoD Comptroller's performance measures initiatives described earlier in this paper; it is discussed below. The third is an initiative of the Governmental Accounting Standards Board, which is also discussed below.

The Comptroller has required the use of work process tools and measures to support achievement of output goals. As noted, work process measures contribute to improving output efficiency or effectiveness. Some work process measures complement other measures. The Comptroller notes that flow charting of specific processes may be useful in measuring performance, as is work force and organizational assessment.[8]

The comptroller identified a number of steps to be taken: facilitation of the use of work process improvement tools, systematic identification and codification of work process tools, identification of key work process measures, updating of work process measures, and training and educating people on the roles and applications of work process.[8]

"Reducing cycle time to reduce the resources invested in the production pipeline over the production cycle, is closely correlated with total cost per output. It is not anticipated that a separate cycle time indicator will be included as an efficiency measure in budget documents. However, on-time performance will be recommended as an effectiveness measure. General categories of output effectiveness measures include quantity, timeliness, quality, and customer satisfaction."[8]

Focus on the concepts for improving delivery of services is certainly not confined to DoD or to the Federal Government. To develop a broader discussion of the information necessary to assess the performance of service providers, the Governmental Accounting Standards Board is seeking comment on efforts to measure outputs in the provision of Government services. This is a step toward a Statement of Governmental Accounting Concepts.

There is a clear link between the needs of the overall operation of government (public administration) in making decisions and the needs of the citizenry in assessing the accountability of the administrators. Traditional governmental financial reporting has attempted to provide accountability and decisionmaking information primarily about fiscal stewardship.[3]

The Governmental Accounting Standards Board cites three separate aspects of operations that must be considered: economy, efficiency, and effectiveness. These objectives can be better achieved if management understands the organization's process flow.

CONCLUSIONS

Even well-run acquisition organizations with long and successful operating histories are unlikely to have process flow diagrams documenting the steps in the acquisition process. But without a documented process flow, staffs are left to follow the undocumented process by rote. Lack of a documented process flow can have an adverse impact upon an organization's ability to make quality awards in a timely manner. This is particularly true when processes change fairly rapidly or when individuals leave or move within the office, and as outside circumstances affect the organization's mission and responsibilities. Yet, in spite of the many good reasons for having a well-documented flow, documentation of the various steps in the process or of the various activities is seldom required or created.

Without a documented process flow already in place, it is time-consuming and expensive to diagram the existing procedures. But because process flow is the cornerstone on which so many improvement techniques are based, the effort is necessary.

Perception seldom matches reality in acquisition process flow. The steps actually being performed may not be those that the participants or managers think are being performed. As a result, decisions are often based on intuition rather than on fact. Lack of documented process flow often spawns a breakdown in organizational communication, resulting in finger-pointing and mistrust. This situation is further exacerbated without adequate monitoring and tracking systems that identify the various steps and those responsible for them.

Without a documented process flow, standard processing measurements (e.g., time), are unavailable for most steps in the overall acquisition cycle, except perhaps for the contracting phase itself. This portion of the process is the one most likely to have regularly published standard steps and processing times.

While many steps are similar from one organization to another, with only a small percentage unique to a specific organization, few attempts have been made to standardize the process flow from organization to organization.

We found through process flow analysis that there is inadequate linkage between the program planning and budgeting process. We also found no obvious impediment to starting the planning process earlier; there is no need to delay it until the budget has been submitted to Congress, since each current year's appropriation has a strong correlation with the previous year's. Therefore, the project planning process

can begin with the initial formulation of the budget and continue as the budget process progresses.

In addition to the benefits of process flow diagraming and analysis that have been discussed, the following advantages may also result:

- Evaluators can compare reality with perceptions
- A baseline can be established
- The document can be used for training and educating new employees
- Project officers can better estimate the total processing time, including all of the "downstream" steps
- Contracting officers can gain appreciation for all of the "upstream" steps that must occur before they see the purchase request
- Management can better estimate the impact of new programs on an established baseline.

This paper has described the work that LMI has done in the area of process flow documentation and analysis and has attempted to suggest the benefits of documenting process flows. The continuing need for better public administration, as well as the requirements posed by new initiatives, make documented process flow diagraming and analysis even more important now than previously.

REFERENCES

[1] David Osborne and Ted Gaebler, *Reinventing Government*, New York, 1992, p. 87.

[2] Martin K. Starr, *Production Management*, 2nd ed., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1972, pp. 224 – 225, 258.

[3] "Preliminary Views of the Governmental Accounting Standards Board on Concepts Related to Service Efforts and Accomplishments [SEA] Reporting," December 18, 1992, Governmental Accounting Standards Series No. 093-A, pp. 3 – 9.

[4] Executive Order 12637, dated April 26, 1988, *Productivity Improvement Program for the Federal Government.*

[5] *Work Process Improvement Guidebook*, NASA/JOC, Houston, Texas, December 1991, pp. 1 – 1, 1 – 2, 1 – 5.

[6] Michael Hammer, "Reengineering Work: Don't Automate, Obliterate," *Harvard Business Review*, July-August 1990, pp. 104 – 112.

[7] Chief Financial Officers (CFO) Act of 1990, and its implementation by the Office of Management and Budget.

[8] DoD Comptroller, memorandum of October 29, 1992, to the DoD Service Secretaries and DoD agency heads, *Performance Budgeting*, pp. 3 – 8, 14 – 21.

MAKE QUALITY HAPPEN - MERGED TECHNOLOGY FOR LEADERSHIP

MICHAEL G. KRAUSE and JOHN P. McGOVERN
DEFENSE SYSTEMS MANAGEMENT COLLEGE

ABSTRACT

The Malcolm Baldridge National Quality Award's (MBNQA) strength is the criteria and review process used to assess an organization's quality improvement process. Organization Development (OD) techniques can be an integral part of the process an organization uses for achieving excellence based on the MBNQA criteria. Top leadership is the key factor for success using either strategy for organizational change. They must create a climate which supports and reinforces employee motivation to perform quality work. Leaders must be involved and visible, articulate values, and demonstrate consistency. This paper describes the value of linking these powerful and influential concepts for increased organizational effectiveness and quality improvement.

INTRODUCTION

Total quality is a key factor related to an organization's productivity or to the level of services delivered. Since 1988, the Malcolm Baldridge National Quality Award (MBNQA) has been an constructive and influential initiative for US industry to regain its competitive edge. The strength of the MBNQA is the set of criteria and the review process used to assess the effectiveness and success of an organization's quality improvement process. Criteria cut across functional and organizational elements.

Organization Development (OD) seeks to improve organization effectiveness using techniques that have been evolving since the late 1950's. For maximum impact, OD efforts need to be systematic and planned for the entire organization. Behavioral science interventions in the organization's processes should be designed to align organization and business objectives. The process must be supported from the top down to maintain the organization's vitality and competitiveness. Because of the behavioral nature of most OD interventions, collaborative work efforts are also enhanced. These techniques often amplify individual potential and sense of self-worth which also has an added value for the organization.

EVOLUTION OF TQM[1]

Before World War II, the War

Department saw a need to control the quality of materials and manufactured products. In December 1940 the American Standards Association was asked to begin a project to apply statistics to the quality of materials and products to be used in the war effort. Three classified standards were developed and used by the allies. These standards addressed product and parts sampling and process control charts.

Shewhart did much of the early work describing process variation in descriptive terms. He found that all types of repeatable activities, from manufacturing to administrative processes, are characterized by variation. This lead to his recognition of the importance of being able to monitor these processes to detect changes.

During the fifties, American industry could not make products fast enough to meet the pent up demand. Quality control learned and required for the war effort was secondary to sales and production. In Japan, however, statistical quality control charts were being used to monitor variability and product acceptability. With quality as a strategic priority, the Japanese realized that if a process resulted in defects, even the best inspection methods would not eliminate the problem. They noted that products made without defects produced significant savings which were more cost effective than inspection or defect repair.

There were still US companies using technical and statistical tools to ensure product quality in the sixties. Major companies, especially those who were involved in the war effort, had formal quality and reliability organizations that practiced statistical quality control along with design of experiments and reliability engineering. Over the decade, these methods began to fade as the United States continued to experience phenomenal market growth. Quality took a back seat to delivery.

American market growth continued through the seventies. At the same time, Japan's world competitiveness began to take hold. Japanese products began taking over market share because they gave consumers superior quality for less money.

How did the United States lose so many product markets to the Japanese in such a short time?

- In the fifties, the Japanese started to institutionalize the delivery of quality products and services

- All management levels recognized that quality of product or service not only results in increased customer demand, but is cost competitive

- All employees are expected to participate in any activity that can increase effectiveness

- Employee contributions are sought out and recognized by management

- Teamwork throughout an organization is essential and a core value

- The quarterly statement is not the bottom line, rather it is to make the enterprise "re-

cession proof" (The CEO of Ricoh Co., LTD., 1975 recipient of the prestigious Deming Award, stated "... to make our company recession proof, with true sale and technology capabilities.")[2]

Attitudes in the United States began to change during the eighties. One catalyst was the NBC white paper, "If Japan Can ... Why Can't We?" Six months after the broadcast, Ford Motor Company contacted Deming for help using quality improvement as a competitive strategy.

Deming's major thrust in the 40's was statistical process control (SPC); however, by 1980 his major emphasis had turned to managerial matters. Deming wanted to "create a prairie fire that would consume all America and turn it around."[3] Dr. Deming's 14 points are a prescription for a company's competitive success. In his seminars, he is continually telling American management they are responsible for approximately 85 percent of the problems faced in industry and business.[4]

Work with Deming led Ford to form a multifunctional team consisting of approximately 100 people who moved in and out of the team (called the Alpha Team) on a rotating basis. Education of the entire corporation on quality and cooperation was important, and extensive time was spent developing values and guiding principles.

Although you couldn't prove it by sales of books espousing successful Japanese, not American, management techniques, industry and business leadership is changing. We now expect two way vertical communication between management, and have employees participate on teams that are allowed to tell management how organizational performance can be improved.

EVOLUTION OF ORGANIZATION DEVELOPMENT

Organization Development implies *change*. Traditionally, OD efforts are facilitated by individuals with behavioral science backgrounds, rather than business or engineering backgrounds. OD techniques and consultants are useful for managers seeking to plan and implement change, and enhance the potential for individual and organizational growth through a balanced concern for people and for organization performance.

When interventions occurred at the top of the organization, there was often a lack of congruence between what the executives said, and what they did. In today's TQM jargon they "didn't walk their talk." Often, the top leaders were over dependent on outside help, and sought to accomplish significant changes in too short of a period. For change to have a lasting impact, it must cut deeply into the organization's structural processes and systems, and lead to the modification of employee attitudes and motivations through empowerment, participation, trust, and cooperation.

Mayo's work at the Hawthorne plant of Western Electric in the 1930s set the stage for the

human relations school of management. During the forties, Lewin's "field theory" provided the foundation for seeking more effective organizational change. His three steps (unfreezing, movement, and refreezing), while simple, are very powerful when combined with analytic methods such as force field analysis.

Despite the name, much of the early practice of organization development was at the work group level, and relied on experience based activities. Laboratory Training (T-groups) were recognized as a means to affect individuals and work teams. The intent of these activities was to change the organization. McGregor's "Theory X" and Maslow's description of a needs hierarchy topped by self actualization provided a viable scheme to help managers understand their work force during the late fifties. McGregor applied laboratory training to large systems (Union Carbide), and Blake and Shepard offered their T-group services to improve relationships between top managers. The University of Michigan's Survey Research Center was established and used a model of diagnosis, feedback, and action.

Many OD consultants are only concerned with the human processes found in organizations, despite the fact that Trist described organizations as a sociotechnical system starting in the 1960s. His work lead to the idea of open system planning in which it was essential to recognize that the organization is affected by its environment. This was further enhanced by Katz and Kahn's multidimensional social system. Likert's strong advocacy of participative management and system level thinking based on his four models for organizational design and the concept of managers as linking pins between organization levels also added to the practice. Managerial Grid surfaced as a development concept, and strategic planning took on greater importance.

During the seventies, Managerial Grid became one of the most popular OD techniques. It was often linked to strategic implementation, management by objectives, and ultimately to organizational plans. Hackman and Oldham emphasized job satisfaction, while Herzberg described motivating conditions. By the middle 1970s, Weisbord[5] proposed a "six box" model for organizational diagnosis. Weisbord's model also contained provisions for assessing the organization's environmental interface. The six boxes are:

<u>PURPOSE</u> - The business or mission of the organization

<u>STRUCTURE</u> - How work is divided

<u>RELATIONSHIPS</u> - How people work together, manage conflict, and use technology

<u>REWARDS</u> - How work tasks are incentivized

<u>HELPING MECHANISMS</u> - Techniques and technologies which allow activities to be coordinated

<u>LEADERSHIP</u> - The person or people who keep the first five boxes in balance

In the 1980's both worker (motivation) and customer expectations (quality) were changing. Argyris and Schon described learning in organizations, and leadership's use of espoused theory and practice of management (do they do what they say?). Others advocated the concept of strategic vision. These changes required a refocus of management attention and techniques. As you can see, many approaches by many behavioral scientists permeated US industry during these decades.

ORGANIZATION DEVELOPMENT TODAY

Contemporary organization development techniques along with their inherent objectives now recognize that:

- Management must be sensitive to customer expectations.
- Product and service availability does not mean acceptability.
- Management doesn't have all the answers regarding elements that increase an organizations effectiveness.
- Employee participation is a major key to solving productivity and quality problems.
- Quality of product and service is the major reason (more important than cost) for purchase decisions (at least in the commercial sector).
- The direct labor cost that was the major thrust of management's plans, direction, controlling, etc. has shrunk from the 30-50% of the work force in the 60's and 70's to the 10-15% range in most industries today.
- The factors that affect a company's performance, quality and productivity are found in all segments of the organization -- marketing, finance, personnel, design, engineering, procurement and manufacturing.

Organization Development practitioners believe they are change agents. In combination with a systems approach, internal and external OD consultants intervene at the work group level. They use applied behavioral science to change organizations and their processes. This normally includes establishing on-going normative reeducative strategy for change.

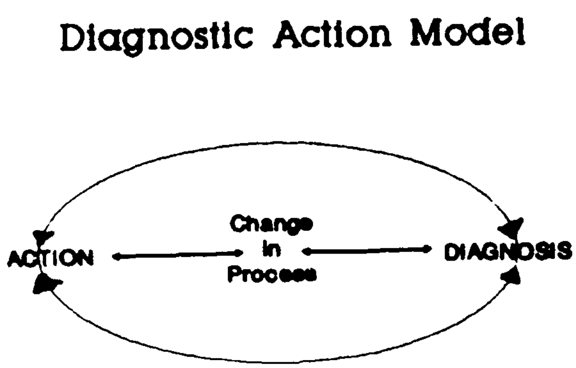
Organizational goals are their target. The goals must flow from the organization's purpose, and may be etched throughout the organization with vision and mission statements. Top leaders of the organization must create an organization climate which supports and reinforces employee motivation to work toward and achieve these goals and belief in quality (which may seem distant or nebulous from the lowest organizational levels.)

Collaboration was highly valued by the OD practitioner. Many efforts had limited impact since teams were involved in working things out, rather that asking senior executives to clarify goals or establish priorities. These teams also failed to communicate to top management their views of where executives attention should be focused.

Organization goals can be

achieved by diagnosing the current situation, taking action, and reassessing the progress. This often results in a change of process as shown in Figure 1. Individuals in the organization are expected to learn from the experience (they are part of action based research where both they and the consultant are part of the "experiment.") The five areas which follow are typical of those explored during the diagnosis phase.

Figure 1



● **Communications**: Who talks to whom, how often, and about what? Do the communications fit the nature of the jobs? Observation, surveys, interviews, focus groups, or analysis of audio or video tape are used to gather the data.

● **Leadership/Boss Subordinate Relationships**: How do the bosses relate and lead/manage? What is their style and its impact? Assessment can be accomplished through questionnaires, interviews, and observation.

● **Decision Making and Goal Setting**: Who does it? Who participates and how? Do they have the skills? Do they have both short and long range insights and temperaments? Data can be gathered by observation, and consequence analysis.

● **Conflict Resolution**: Where do the conflicts occur? What methods are used? Does the organization have a formal process? How are they managed? What is the impact of the reward system on conflict? Interviews and observation are the best way to get at the heart of this area.

● **Managing the Interface**: How do two parties get along? This can be a subset of conflict resolution, and ties into the goals of the organization and its subordinate units. Thus, the need for consistency. Interviews, surveys and observation are the best means to determine impact.

THE BALDRIGE PROCESS

So that our competitiveness would not be completely lost, the country needed to influence and support business. This concern resulted in Congressional enactment of the Malcolm Baldrige National Quality Award (MBNQA) into legislation in 1987. The purpose was to foster:

- Awareness
- Recognition
- Information transfer

Whether some detractors think it or not, the most effective response to global competitiveness is the MBNQA. Many states

and countries have adopted the award. It is used by companies applying for the national award and, more frequently, for self-assessment for continuous improvement. Manufacturing, service and small business companies can apply for the award. Whether applying for the national award or for self assessment, the process is generally the same.

A description of the company's quality management system is recorded in response to the MBNQA application guidelines. Guidelines cover seven major categories, twenty-eight sub-categories and a total of ninety-two specific items. Major categories and point allocation are:

Leadership (95)

Information and Analysis (75)

Strategic Quality Planning (60)

Human Resource Development and Management (150)

Management of Process Quality (40)

Quality and Operational Results (180)

Customer Focus and Satisfaction (300)

The company's quality management system description is reviewed by a group of examiners. They note the strengths and areas needing improvement for all 92 items. Scores are then recorded for the sub-categories based on the strengths and weaknesses.

In the national process, the examiner's reports are evaluated by judges. Based on scores and comments, the judges may refer the application back to the examiners for another review. This second phase review requires consensus for areas of significant examiner deviations on the scores or comments. During the second review, they also indicate the site visit issues for verification and clarification of data presented. A site visit is the last step for the national award finalist. This process is the model (see Figure 2) used by most companies for self-assessment.

Figure 2

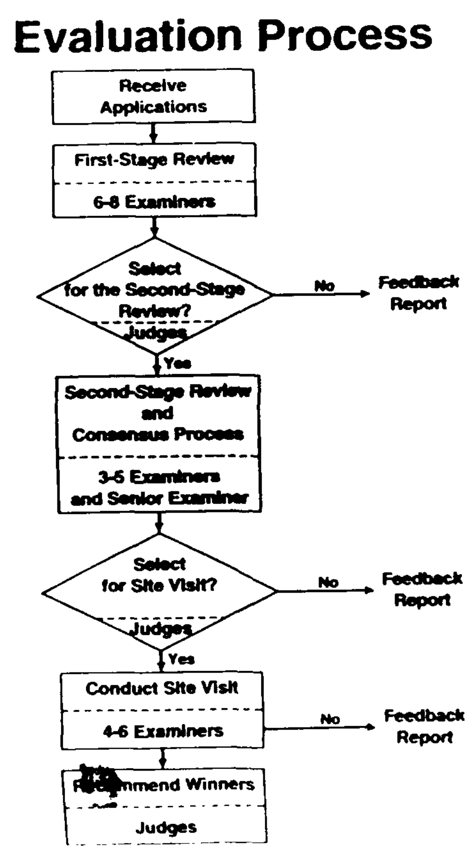


Table 1

Areas of Weakness

ORGANIZATIONAL DEVELOPMENT	BALDRIGE PROCESS
Non-technical/Soft science	Non-prescriptive
Non-tangible bottom line	Concentration on quality improvement clouds bottom line
Organizational effectiveness undefined	Written material is the major assessment vehicle
Intrusion of outside consultants into the organization	Difficult for a company to think and speak in unity
Client system is usually a small part of the organization	Disregards organizational structure

The journey for quality improvement based on Baldrige criteria most often has significant impact on the way people are treated, empowered, recognized and rewarded. It also impacts the manner in which management leadership is practiced, and how productivity and quality (effectiveness) is improved.

A SYNERGISTIC MERGER

The major area where MBNQA and OD come together is **LEADERSHIP**. While we have been noting the historical perspective and techniques of these approaches, we should note some shortcomings. Table 1 above depicts some OD and MBNQA areas of weakness.

When American firms were making extraodinary levels of profits, industrial leadership was frequently made the prerogative of financial managers. Leaders managed for growth, with little concern for improvement of product and services. Business schools advocated a general theory of management; i.e., a good manager can manage any type of enterprise. A person need not know anything about steel to head a steel company, have railroad experience to manage a railroad company, etc.

These executives and managers were action oriented and wanted to solve their own problems. They often reached the top without adequate preparation to handle a rapidly changing business and world environment since their cultural heritage was based on quarter by quarter management. They were the stars. Yet many were not ready to recognize the transformations which were needed when threatened with price and quality competition, or new market opportunities.

If we agree with the above and

keep these weaknesses in mind, OD and MBNQA processes can complement each other. Greater improvement and success can result. Leadership is the common element where OD and Baldrige come together and can illustrate the strength of this synergism.

Leader's seek goal attainment. They need to be able to fully mobilize people and recognize the need for congruence between people, process, structure and environment. Highly effective leaders recognize that values can't be imposed. Thus, they know it is essential to create an organization culture in which employees share the same or similar goals as managers. The MBNQA can provide the target for both to focus their energy.

Customer focus and satisfaction is heavily weighted by the Baldridge point allocation. With the organization paradigm shifting toward a customer focus, there is a need to recognize the worker may be caught in the middle. If the customer desires something, how responsive should the employee be if his or her boss still controls the organization's rewards?

To increase the liklihood of a successful quest for the top levels of the Baldridge, leaders can undertake an OD program. With the appropriate choice of process and interventions, OD can build trust between organization levels or between organization functions; advocate an open problem solving climate; relocate decision making and problem solving to the source of information; increases the sense of individual ownership; move toward greater collaboration; and increase awareness of group process. The basic value is one of individual choice, within a joint action planning framework. This fits nicely into the concept that each person should be responsible for quality.

Such a program blends with TQM which seeks to align work through the common focus of customer satisfaction, and is accomplished by seeking methods to continually improve processes, products, and services. The challenge is to control variability so that the result falls within acceptable limits. It requires the entire organization to work together toward common objectives. Leaders must be involved and visible, articulate values, and demonstrate consistency. Leaders would do well if they learned and used OD's process consultation and team development techniques.

CONCLUSION

The MBNQA establishes a framework for a systematic appraisal and diagnosis of quality improvement system problems. Quality and productivity measurements of the Baldrige criteria need to be tied into OD's effectiveness. Many OD techniques can be an integral part of the process organizations use to achieve or exceed the Baldridge criteria since these techniques improve communications, teamwork, involvement, and cohesiveness.

Top leadership is the key factor for success using either strategy for organizational

change. However, the implementation strategy for a quality program must be well thought out if the desired success is to be achieved. With the marriage of quality and productivity goals and results to business goals and results, a company can address the Baldridge criteria more easily and more effectively. Meeting these criteria can be reflected in the organization's strategic business plan.

ENDNOTES

1. This section is summarized from: McGovern, John P. "The Evolution of Total Quality Management," *Program Manager,* September/October, 1990 pp 16-22.

2. Ishikawa, Kaoru *What is Total Quality Control? - The Japanese Way* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1985) P 94.

3. Walton, Mary *The Deming Management Method* (New York: Dodd, Mead, 1986) P133.

4. Notes from "Deming Four Day Seminar," May 1988.

5. Weisbord, Marvin R. "Organizational Diagnosis: Six Places to Look for Trouble With or Without a Theory," *Group and Organization Studies* 1 (1976), pp. 430-437.

PREREQUISITES FOR THE ESTABLISHMENT OF A PROFESSIONAL ACQUISITION WORKFORCE, REVISITED

John Krieger, CPCM, Chief, Procurement Policy and Procedures, Internal Revenue Service, and Elaine Larison, CPCM, Policy Analyst, Internal Revenue Service

ABSTRACT

The goal of establishing a professional acquisition workforce is becoming more and more important as the number and complexity of laws, executive orders, and regulations continues to increase with no end in sight. This goal can be achieved only through a concerted team effort between Government, Industry and Academe. This team effort is being put into place: The Department of Defense (DoD), with the prodding of Congress, has instituted requirements for a professional acquisition workforce; the Office of Federal Procurement Policy (OFPP) has issued a Policy Letter designed to levy similar requirements on Civilian Agencies; the Federal Acquisition Institute (FAI) has published the long awaited Contract Specialist Workbook; there is an increase in the number of colleges and universities offering acquisition courses and degrees; and, there is an increased demand, from the private sector, for educated and trained acquisition professionals. The goal appears to be within view.

This paper is a ten year update to a paper presented at the 1983 Federal Acquisition Research Symposium. The paper explores what has occurred in the intervening years to establish a professional acquisition workforce. It presents the results of a replication of the initial study's review of advertisements in newspapers and Contract Management magazine. Finally, it explores where the efforts to establish a professional acquisition workforce are headed and what still remains to be accomplished.

INTRODUCTION

In June, 1990, the National Contract Management Association stated, "Keeping up with the technological changes and meeting the challenges of the 1990's will require an educated, experienced workforce committed to a high degree of expertise, performance excellence, and ethical standards - in short, professionals." (5) Many professions establish specific requirements for their professionals; doctors, lawyers, certified public accountants, nurses, real estate agents and stockbrokers all have educational/degree requirements, certifications and/or testing requirements in order to work in their fields. It is reasonable, and necessary, to expect that for acquisition to truly become a profession, it must have specific education, training and experience criteria with accompanying certification requirements. The theme of the 1993 Acquisition Research Symposium, "Acquisition for the Future: Imagination, Innovation, and Implementation" is especially relevant to the issue of acquisition professionalism. The goals have been imagined, now the innovation and implementation are necessary. The original exploration of this topic was presented at the 1983 Federal Acquisition Research Symposium, which

had the theme, "Government, Industry and Academe: Synergism for Acquisition Improvement." (7) As was stated in the previous paper, the goals cannot be reached without true cooperation and organization of efforts among the three players: Government, Industry and Academe. Each element of this necessary "triumvirate" has made efforts towards the goal and there appears to be some coordination of efforts. However, stronger teamwork and change are still needed. Change is not easy. Just as there are change agents, there are its foes. As Robert F. Kennedy said, "Progress is a nice word. But change is its motivator and change has its enemies." (9) Throughout this paper we will explore both these change agents and the enemies of change, what has been achieved and what is left to be accomplished.

GOVERNMENT

In a March, 1991, article, Dr. James H. Edgar, CPCM, stated, "The qualifications, training, and personnel management of individuals assigned to acquisition positions have been matters of long-standing concern to Congress as well as to the executive branch." (6) The Office of Federal Procurement Policy (OFPP) was established within the Office of Management and Budget (OMB) in 1974 to provide overall direction of procurement policies and to coordinate programs to improve the quality and performance of agency procurement personnel. (19) OFPP had an original authorization for a five-year period and was reauthorized twice, for four years each time. In 1988, Congress enacted the Office of Federal Procurement Policy Act Amendments which finally established OFPP permanently. Clearly, Congress recognized that establishing a professional procurement workforce was going to be a long and drawn out process.

The attempts by OPM to lower grade levels of acquisition personnel, described in the previous paper, have been stopped. The grade levels have been maintained. In fact, in 1989 OPM reclassified the 1102 series from administrative to professional. This was a great step forward in enabling the establishment of a professional acquisition workforce. But we must ensure that we follow through.

Although there still is some promotion of clerical and administrative personnel into the acquisition field, the Government is bringing more college graduates into the field. FAI's 1992 report identified that of the 2,435 total hires into the 1102 series, in FY 1991, 1,728 were from other Government fields. Although many may have been clerical or administrative personnel, 40% were college graduates, an increase of 7% from the previous study. And 52% of the college graduates had degrees in business, law or public administration. Statistics for the degree field were not even available at the time of the previous study. Of the 644 recruited from outside the Government, 85% had college degrees (61% in business, law or public administration). In 1991, the percentage of contract specialists with a Bachelor's Degree was 53%. Sixty percent of the 1102's with degrees majored in business, law or public administration. While these numbers may be impressive, it cannot be shown that there has been an increase in the overall number of 1102's with Bachelor's Degrees in business or business related fields. The reason for this inability to compare statistics is, as Professor Harry Page stated, in testimony to a Senate subcommittee in 1986, describing education levels of the federal procurement workforce at that time, "Perhaps one third are college graduates and *no one knows how many of these have actually studied business and management or related subjects*

(emphasis added)." (12) In the future, we will be able to track any improvements in this areas. The FAI study found a positive relationship between lengthy experience in the 1102 series and the likelihood of having a Bachelor's Degree. Sixty-one percent of the personnel who had been in the 1102 series at least 15 years (at the time of the 1991 study) had Bachelor's Degrees. It is possible that the additional years of service gave personnel more time to earn degrees. (18)

To add to the somewhat promising statistics on education and degrees, FAI reported that FY 1991 had the lowest loss rate of 1102's since its reporting started in FY 1978, resulting in personnel having more experience in the field. Fifty-six percent of the 1102's had more than six years experience in the series. But surely that is insufficient for a truly professional workforce. These statistics show some progress is being made, but our inability to retain people for longer periods does not bode well for continuity or quality. Unfortunately, a major potential solution to retention, higher pay, is the deadly enemy of deficit reduction.

OMB's Policy Letter 92-3, entitled, "Procurement Professionalism Program Policy - Training for Contracting Personnel," affirmed that "The quality of contracting actions depends largely on the professional skills of the Government procurement workforce to help meet agency mission needs." (14) This Policy Letter established a Government-wide training standard for skill-based training in performing contracting duties.

Janice M. Menker, CPCM, of the Defense Systems Management College, stated, "Education and professionalism do not come cheap. As federal and state budgets decline, government must do more with less. To which does the government give priority - education or goods and services? Industry must also make a choice - invest in education and training or maintain competitiveness in the market." (10) The cost of the education of the acquisition workforce must be considered in light of the magnitude of the cost of the goods and services that the workforce purchases and the benefits to be achieved by such training. "In 1991, over 31,000 Federal procurement professionals were responsible for purchasing more than $191 billion in goods and services for the Federal Government." (20) The quality of workers responsible for contracting and procurement actions has come under close scrutiny. The growing budget deficit and allegations of waste and mismanagement have contributed to this attention. As was stated in the report from the DoD Advisory Panel on Streamlining and Codifying Acquisition Law, there is, "widespread public perceptions that the term 'Government procurement' is synonymous with 'scandal'." (17) We must be willing to spend the comparatively few dollars that education and training will cost us, so that we may be better stewards of taxpayer dollars.

The Merit Systems Protection Board's 1992 study, warned that the training area is still lacking, especially Government-provided training courses which focuses on procurement. Many personnel have completed basic courses (81% completed basic procurement management and 70% completed contract administration). Although these statistics give us pause to assess the effectiveness of training programs, the study also found that only 51% had completed advanced procurement management and only 38% had finished the advanced contract administration course. (20) This finding does not show much

improvement over the information given in the earlier paper. The lack of advance training by a large percentage of the workforce is disturbing for several reasons. One reason is that training results in employees being better prepared to handle the complex problems which arise in contracting. The Merit Systems Protection Board demonstrated, statistically, that there is a positive relationship between the number of training courses completed and performance ratings. This was the only area where the Board found a strong correlation. (20) A second reason is that, with personnel staying in the procurement field for longer periods, there should be a higher percentage of personnel who have qualified for, and completed, advance training courses. Just working in the procurement career field is not enough, advance training courses are required in order for personnel to be prepared to handle the more complex work which should be assigned to the most experienced workers.

A higher percentage of degreed personnel entering the field and a slightly more stable workforce are helping to develop a professional acquisition workforce for the Government. But much needs to be done, particularly in the areas of retention and advanced training. However, given the current budget-cutting atmosphere, there should be concerns that promotion and wage constraints will erode advances in retention and that training will be more difficult to justify from a strictly budgetary viewpoint.

The Department of Defense (DoD) has made strides towards a professional acquisition workforce. In 1990 Congress adopted the Defense Acquisition Workforce Improvement Act (DAWIA). This Act is intended to improve the quality and professionalism of the DoD acquisition workforce. In addition to recognizing acquisition as a professional career field, capped by admission into a professional Acquisition Corps, several other policies are established: requirement to improve the education, training, and experience levels of the workforce; a career development program for acquisition professionals; a career management structure in DoD; a Defense Acquisition University structure; and, programs to assist acquisition personnel in their professional development. The law is being phased in over a three year period, ending in October, 1993. Each of the Services is working to implement the requirements of the Act.

The Defense Acquisition Workforce Improvement Act has mandated certain education requirements. Those personnel who hold degrees in other than business-related disciplines must complete at least 12 semester hours of business-related courses to enter a DoD Acquisition Corps. The requirement for Contracting Officer positions is even more stringent; at least 24 semester hours of business-related courses, if the individual's degree is in a discipline other than business-related. (4)

There is one major problem which effects all of DoD and effective implementation of the Act. This problem is the huge backlog of training requirements. Acquisition personnel are attempting to sign up for required courses and for newly created courses. Personnel needed for critical acquisition positions are being given priority to attend needed training. There is a concern that senior personnel are being sent for training irrespective of whether their prior work experience made such training superfluous. DoD must solve this problem so that less senior personnel can enroll in training courses and become prepared to take over critical positions. One potential solution has been preempted on an ad hoc

basis: although DAWIA authorizes waivers of the training requirement, there is great reluctance to use waivers, as neither commands nor individuals want to have waivers of training requirements as part of official records. The problem of meeting the training requirements is being addressed by additional course offerings, and in time, it will be overcome.

The Air Force, seemingly a leader in the strive to develop a professional acquisition workforce, has formulated the policies necessary for reaching the goal. The Air Force's 24 January 1992 Memo, entitled, "Certification in the Contracting Acquisition Professional Development Program (APDP) - ACTION MEMORANDUM," states, "The Acquisition Professional Development Program is designed to provide the contracting community with a structure that ensures our people get the necessary training, education, and experience to effectively progress into more responsible and demanding positions." (2)

The Army also appears confident in reaching the goal of professionalism. The Army Research, Development and Acquisition Bulletin, in describing the Army Acquisition Corps (AAC) stated, "The program will build a world class acquisition workforce." (1) The AAC has been set up to provide civilian Corps members with opportunities for professional development throughout their careers. For the military members of the AAC, the Military Acquisition Management Branch was formed with career management responsibilities. (3)

Civilian agencies are much further behind the military in the formulation of a professional workforce. The agencies are working to address the requirements of the Office of Federal Procurement Policy's Letter. The information on the program is now being disseminated throughout agencies and progress is being made to implement the requirements. For example, the Treasury Department has implemented, in June, 1992, the Procurement Career Management Program guidelines which was designed to, "Meet the Department's needs for professional contracting and purchasing personnel and to provide, on a planned systematic basis, highly qualified candidates for senior contracting and procurement positions as they become vacant." (13) The guidelines recognize and incorporate the FAI Contract Specialist Workbook into the Department's program.

INDUSTRY

The second component of the triumvirate is Industry. The replication of the newspaper advertisement analysis that was conducted for the original study showed that Industry has made some significant advances. A study of 167 advertisements for contracting professionals appearing in the Washington Post during the period from 26 July 1992 to 1 February 1993 showed a stronger commitment to professional requirements. The current study found that 64.44% of the advertisements had degree requirements, a considerable improvement over the earlier study which found only 20.44% with such requirements. One advertisement in the current study even gave the requirement of a Bachelor's Degree and formal training in acquisition. However, this still means that over one-third of the advertisements did not levy degree requirements.

A particularly disturbing finding was that only one advertisement stated a requirement that the candidate be a Certified Professional Contracts Manager (CPCM), although five other advertisements did note that CPCM status was desirable. This 3.46% mention

of professional certification is an increase from the previous study's 2.89%, but is certainly not the increase that would show a true commitment to professionalism. According to Dr. David Lamm, Professor and Academic Associate, Acquisition and Contract Management, Naval Postgraduate School, "The CPCM designation continues to represent the highest level of qualification in the contracting profession." (8) Given this high regard it is somewhat surprising that there is not more recognition of the certification.

When these first findings are coupled with other statistics from the advertisements the commitment to professionalism is really questioned. In the current statistics only 2.39% of the advertisements stated a requirement for acquisition training. While that is a "tremendous increase" over the previous finding of 0.44% it's still negligible. Compare the training requirements to the almost four percent (3.46%) of the advertisements in the current study that gave typing (from 45 words per minute up to 65 words per minute) and shorthand as requirements. That percentage is the same as the number requesting professional certification and significantly more than acquisition training. One wonders what portion of the contracting work is seen as the most important, negotiating appropriate and solid contracts or the fast typing of memoranda of actions. Perhaps a little more understandably, computer skills are also deemed to be very important. Seventy-three percent of the advertisements were for positions that required computer skills, with <u>LOTUS</u> and <u>WORDPERFECT</u> the most often cited. If frequency is an indicator of the importance to the company, then computer skills are more important than actual contracting experience, which was mentioned in only 68.26% of advertisements.

Although great strides are hard to determine, there are signs that industry is aware of the need for a professional acquisition workforce, at least on an individual corporate basis. One example of a firm taking the responsibility seriously is Honeywell's Space System Group in Clearwater, Florida which convinced Florida Institute of Technology to open a satellite campus close to their worksite. The success of Honeywell's focused approach is proven when it is shown that 50% of Space Systems Group's contract management professionals have advance degrees in related fields. In addition, "Honeywell requires its contract managers to have a CPCM certificate before they can be promoted to the level of senior contract representative." (16) This is not a burdensome requirement as 65% of their contract managers are already CPCM'S. This is the sort of dedication to training, education, and professionalism that we should see from all corporations.

A survey of the advertisements in <u>Contract Management</u> found a stronger link to professionalism, as would be expected. Although there were only seven advertisements from the August, 1992 issue to the February, 1993, issue, all of the advertisements had degree requirements and 42.86% of the advertisements mentioned CPCM as desirable. We expected this percentage would be higher, given that the magazine is published by the National Contract Management Association, Sponsor of the CPCM certification. The statistics of the current study show some progress from the previous one, which found only a 39.13% of the advertisements requiring certification. However, due to the limited measurement base, this increase should be viewed with caution.

The ultimate goal, that all Industry positions would require acquisition training,

professional degrees and professional certification, is still in the future, but is becoming more of a possibility.

ACADEME

The third member of the triumvirate, Academe, has made impressive strides from the previous study. There has been a noteworthy increase in availability of procurement degrees. As was cited in the initial paper, a 1980 study by the Federal Acquisition Institute indicated that 24 institutions offered Master's Degrees, 7 offered Bachelor's Degrees and 6 offered Associate's Degrees. (11) By December, 1990, the number of institutions offering degrees in contract management related fields had increased to 54 Master's Degrees, 27 Bachelor's Degrees and 21 Associate's Degrees, increases of 770%, 386%, and 350%, respectively. In addition, two institutions, Southeastern Institute of Technology and Arizona State University are offering Doctorate level programs in the field. (15) With few exceptions, the programs are designated acquisition, contract, procurement or purchasing.

In addition to the institutions that grant degrees in the acquisition field, academic courses of 17 colleges and universities have been approved by the Interagency Academic Program Committee as substitutable for federal training requirements. (15) Certification programs are offered by many colleges and universities, such as the University of Southern California and the University of Virginia. Some such as Florida Institute of Technology and George Washington University offer both degree and certification programs.

The significant increase in college and university curricula in acquisition shows the greatest commitment to a professional workforce seen so far. It was surprising, however, that the synergism, that we need and expect, did not go just a little bit further. A review of the last six issues of Contract Management found that only two universities, George Washington University and Florida Institute of Technology, advertise in the magazine. We would have expected that the increase in acquisition curriculum would be shown in this professional publication.

Although not from a college or university, the February, 1993, issue of Contract Management did include an advertisement from the Federal Publications, Incorporated, listing contract training courses available from the firm. However, the advertisement stated only a listing of courses and did not state whether a certificate is available for completion of courses.

Government and Industry will have to be the impetus behind further increases in degree programs in acquisition. The demand for a professionally educated workforce will result in more degree programs. Competition for jobs in the acquisition corps will most likely result in individuals getting degrees in the acquisition and contract discipline.

Some amount of synergism has been noted, for example, Florida Institute of Technology, in making acquisition courses easily available to acquisition personnel, has located offices and classrooms near the work sites of acquisition offices such as the Army Material Command, NASA, and the Army Logistics Management College. The Government recognized the importance of teamwork and required, in OFPP's Policy Letter 92-3, that the Director of FAI, "Assist colleges and universities in establishing procurement and acquisition courses as part of continuing education,

associate, baccalaureate, and graduate programs." (14) This synergism includes Industry, as was noted earlier, with Florida Institute of Technology's work with Honeywell.

SUMMARY

Although strides have been made, some great, since looking at this subject in 1983, much, much more still needs to be accomplished. Government, Industry and Academe have made some combined efforts toward the goal. The Defense Acquisition Workforce Improvement Act and the Office of Federal Procurement Policy's Policy Letter 92-3 (Procurement Professionalism Program Policy - Training for Contracting Personnel) have levied professional requirements for the Government's acquisition personnel. Industry is, more than ever before, requiring professional credentials of job applicants. There has been a great increase in the number of degree programs in acquisitions and contracts offered at our colleges and universities.

It is hoped that the goal of establishing a truly professional acquisition workforce can be reached when we review the status of acquisition professionalism in 2003. However, this is unlikely without an all out and concerted effort by Government, Industry and Academe.

REFERENCES

(1) "Career Development Update: The Army Acquisition Corps Civilian Component," Army Research, Development & Acquisition Bulletin, March-April, 1991.

(2) "Certification in the Contracting Acquisition Professional Development Program (APDP) - ACTION MEMORANDUM," Assistant Secretary of the Air Force (Acquisition) Memorandum, 24 January 1992.

(3) Chase, Deborah, "Career Development Update: The Army Acquisition Corps," Army Research, Development & Acquisition Bulletin, May-June 1991.

(4) Defense Authorization Act, Public Law 101-510, Title XII - Defense Acquisition Workforce.

(5) "Don't Put It Off Any Longer - Face the Challenges of the 1990's As a Certified Professional," Contract Management, June 1990.

(6) Edgar, James H., "The Defense Acquisition Workforce Improvement Act," Contract Management, March 1991.

(7) Krieger, John D., "Prerequisites for the Establishment of a Professional Acquisition Work Force," 1983 Federal Acquisition Research Symposium.

(8) "Lamm, David V., "Certification - Professionalism in Action," Contract Management, June 1990.

(9) Laurence, Peter, J., Peter's Quotations, Bantam Books, New York, 1977.

(10) Menker, Janice M., "NES Education - The Making of a Professional," Contract Management January, 1991.

(11) "1980 Education and Training Programs," Contract Management, July 1980.

(12) Page, Harry, "Testimony on Federal Procurement Work Force, Senate

Subcommittee on Federal Expenditures, Research and Rules, Committee on Government Affairs," February 26, 1982.

(13) "Procurement Career Management Handbook," Department of the Treasury, June 1992.

(14) "Procurement Professionalism Program Policy - Training for Contracting Personnel," Policy Letter No. 92-03, Office of Management and Budget, 24 June 1992.

(15) "Procurement-Related Education - Where Can You Get It?," Contract Management, June, 1991.

(16) "Professional Development in Contract Management: Corporate Support Can Make the Difference," Contract Management, June 1991.

(17) "Report of the Acquisition Law Advisory Panel, Streamlining Defense Acquisition Law," Department of Defense, 12 January 1993.

(18) "Report on the Federal Acquisition Workforce for Fiscal Year 1991," Federal Acquisition Institute, September 1992.

(19) Smith, Stephanie, "Federal Procurement: A Brief Overview," Congressional Research Service, The Library of Congress, 29 May 1992.

(20) "Workforce Quality and Federal Procurement: An Assessment," A Report to the President and the Congress of the United States by the U.S. Merit Systems Protection Board, July 1992.

APPLICATION OF A TAXONOMICAL STRUCTURE FOR CLASSIFYING FEDERAL GOVERNMENT GOODS

Dr. David V. Lamm
Lieutenant Commander John J. Prendergast, SC, USN
Lieutenant Brian Wenger, SC, USN
Lieutenant Edward W. Sheehan, Jr., SC, USN
Naval Postgraduate School
Monterey, CA 93943

ABSTRACT

This paper is the report of a continuing research effort to develop and apply a method for classifying various goods procured by the Federal Government according to key characteristics and attributes exhibited by these goods. The primary objective has been to develop a classification scheme (model) that can be used by practitioners and researchers in grouping goods along a continuum from simple to complex utilizing strategic characteristics essential to the buying process.

A taxonomical model for classifying goods versus characteristics was developed utilizing cluster analysis [1] and was subsequently validated through continuing data collection and analysis.[2] The latter stages of the research have focused on clarifying application of the model in the buying environment including refinement of acquisition policies and procedures reflecting differences between classes of goods, use of market research techniques, training and educating the workforce, developing a better understanding of the relationships between goods, and developing staffing models, to name a few.

INTRODUCTION

One of the most potentially significant concepts proposed in the field of Government contracting is the idea that contracting is a science. This came about as a result of the growing complexity and increasing difficulties in the procurement process. These problems emphasized the need for procurement research as a means of obtaining a better understanding of the intricacies and effects of the process. The key to effective research is the use of a systematic approach to solving problems. The concept of contracting as a science implies that a systematic and organized process can be employed for development and validation of contracting knowledge. [3]

Among the requirements identified as differentiating sciences from other disciplines is the description and classification of the subject matter. [4] The pursuit of this requirement has lead to the development of a taxonomical structure for classifying goods procured by the Federal Government. (See Figure 1 for the Taxonomy as developed to date.)

The major benefits proposed are that accurate questions could be asked as to how the perceived order of goods has arisen and how best to maintain or improve it, the structure necessary for identifying the types of goods purchased by the Government in a profile that lends itself to increased visibility, and accurate determination of the most viable procurement strategies for buying certain products.

At this stage of the taxonomy's development, it is appropriate to consider its usefulness by examining practical applications and benefits. This is necessary for two reasons. First, it is important to bridge the gap between researchers and practitioners. "Many people in the scientific community believe that research, like virtue, is its own reward. Procurement research is not quit that exalted. Harried administrators and impatient Congressmen want to see results--practical applications that will improve the procurement process." [5]

The second reason to consider practical applications is to provide direction for future research and refinement of the taxonomical model. The most important evaluation criterion of a classification scheme is how useful it is in helping solve problems. [4] In order to refine and advance the taxonomy, the applications for which the model is intended, and the resulting benefits, should be understood.

CLASSIFICATION STUDIES

Classification studies conducted in the field of Government procurement have been a continuation of the concept of contracting as a science. This concept was first proposed by Robert Williams and Paul Arvis in a paper presented to the Federal Acquisition Research Symposium in 1985 [6], and subsequently examined in research conducted by Steven Park in 1986. [3] The concept of framing the field of contracting as a science is useful because it advocates a systematic and organized method for exploring and defining the discipline.

Government procurement is a complex field with conflicting requirements placed on the process by the many goals of the system. For example, the Federal procurement process is expected to obtain quality products at fair and reasonable prices. At the same time, the process serves as an instrument of foreign policy through the foreign military sales (FMS) program, social policy through socioeconomic programs, and fiscal policy through fluctuations in spending levels. The procurement process serves as a tool for carrying out many other policy goals. The result is a complex process with requirements often at odds with one another. Government procurement stands to benefit from an organized and systematic approach to studying the field.

TAXONOMY OF GOODS

Origin

The taxonomical model developed during this study has its roots in the field of marketing and, in particular, the classification scheme developed by Gordon Miracle. [7] The conceptual basis for the classification scheme was to classify Government goods in a way that offers strategic insight into the buying process. The goal was to create a classification scheme that would highlight the various categories of goods and their related characteristics to allow streamlining and tailoring of contracting policies, methodologies, and procedures.

Objectives

There are several basic objectives of classification in any discipline. Classification is rarely viewed as an end in and of itself. Classification systems are generally viewed as a means to improve the ability to interpret, predict, or control some facet of performance. [8]
The primary objective of classification is to describe the structure and relationships of constituent objects with regard to each other and similar objects. Classification simplifies these relationships in such a way that general statements can be made about classes of objects and boundaries between objects can be identified through differentiation. It is easy to observe structure when it is obvious and discontinuous. For example, horseshoe crabs are a unique species very different from their nearest relatives. Classification is most useful when the structure is less obvious. [9]

Another objective of classification is to achieve economy of memory and facilitate communication. Without the ability to summarize information and attach a label to it, communication would be impossible. [8] Another objective of classification is ease of manipulation of information. Classification achieves ease of manipulation because the system consists of taxa that can be easily named and related to each other. If relationships are complex, labeling or handling of the taxa will not be easy. [9]

Usefulness

In generic terms, the application of a taxonomy to a set of facts or objects results in adding more information to those facts or objects by revealing patterns, enabling predictions, and guiding various decisions. [10] Classification can uncover important differences that may not otherwise be evident, or expose weaknesses in an existing knowledge base that require further investigation.

In describing the usefulness of a human performance taxonomy, Fleishman and Quaintance suggest that the taxonomy has important practical and scientific implications in a variety of fields. They further provide that a number of ostensibly disparate problems can be drawn together and viewed in a new light by the application of a taxonomy. They divide taxonomical uses into scientific-theoretical and applied-practical. The scientific-theoretical applications can be thought of as generic uses. That is, they can be useful in any discipline. Among the most important areas of usefulness are the following: (1) conducting literature reviews, (2) establishing better bases for conducting and reporting research studies to facilitate their comparison, (3) standardizing methods of study, (4) generalizing research to new tasks, (5) exposing gaps in knowledge, and (6) assisting in theory development. [8]

Taxonomies and Contracting

Taxonomies can achieve the same basic objectives in contracting as suggested above. The taxonomy of goods procured by the Federal Government could serve the overall role of advancing procurement research, which would in turn improve the procurement system.

Since the taxonomy is based on the characteristics of goods deemed important in the buying process, it could provide insight into the structure and relationships of goods procured by the Federal Government from the perspective of the buying process. The taxonomy could enhance observation and clarify relationships among the goods. From this, general statements could be made about individual categories of goods which could help guide decisions in the procurement process. The differences identified between the goods in different categories, as well as the similarities between goods within each category, could provide valuable insight for decision making. And as suggested earlier, this process may be most useful when considering goods with less discernable differences than those between a five cent pencil and a billion dollar ship.

By describing relationships among goods, the taxonomy could result in hypotheses about the relationships. In turn, these hypotheses could be tested, providing explanations for the relationships and expanding the knowledge base.

The taxonomy of goods could also achieve economy of memory. This is not to suggest that buyers have a need to memorize the characteristics of goods in each category, but rather, a taxonomy could facilitate communication because it enhances the understanding of the goods and streamlines the communication process. Each specific characteristic of a buy need not be spelled out entirely, the category label could summarize information instead.

A taxonomy of goods could also facilitate ease of manipulation and retrieval of information in contracting. This holds true from both a theoretical research standpoint and a practical application standpoint. By classifying and labeling categories of goods, the taxonomy provides a framework for manipulation and retrieval of contracting information. From the practical application perspective, this provides an efficient means for operationalizing the guidelines developed from the taxonomy. From the perspective of procurement research, it facilitates organized and systematic study.

Finally, the taxonomy of goods procured by the Federal Government could achieve scientific-theoretical usefulness. In much the same manner described in the previous section, the taxonomy could serve procurement research by enhancing literature reviews, establishing a better base for conducting and reporting research studies to facilitate their comparison, standardizing methods of study, generalizing research results to new areas, exposing gaps in knowledge, and assisting in theory development. All of these would expand the body of knowledge in contracting.

Potential Applications

Based on the discussion presented thus far, potential areas for application of the taxonomy of goods procured by the Federal Government are listed below. Although not exhaustive, this list does present the most fertile areas in applying the taxonomy.

1. Market Research
2. Policy Guidance
3. Training/Education
4. Staffing
5. Procurement Reviews
6. Budgeting
7. Legislative Development
8. Regulations/Procedures
9. Contract Type Selection
10. Contracting Method
11. Change Control
12. Break-out Decisions
13. Unsolicited Proposal Procedures
14. Industrial Base Decisions
15. Profit Guidelines
16. Source Selection Procedures
17. Administrative Procedures
18. Clause Selection
19. Specification Selection
20. Configuration Control
21. Independent Research and Development (IR&D) Policy
22. Acquisition Strategy
23. Workload Management

APPLICATIONS

Market Research

Introduction

Perhaps one of the most beneficial applications of the taxonomical structure for

classifying goods procured by the Federal Government is in the area of market research. Market research is an element of the acquisition planning process which has been overlooked in Government procurement. [11] Market research is an area where the taxonomical methods used in the discipline of marketing can be most directly extrapolated to the contracting field. This application of the taxonomy could help shore up a weakness in Government procurement, particularly in these times of declining budgets and a shrinking industrial base.

Market research in the field of contracting can be viewed from two perspectives. From a macro view, market research can advance the body of knowledge in contracting and improve the procurement process by revealing trends in the market that need to be reversed, or practices that work better than others, or policies that enhance competition in general. Viewed from a micro perspective, market research can be used to enhance competition or gain an understanding of production processes for a specific procurement. Market research in contracting is concerned with an examination of the producers or suppliers of goods and services in order to better serve the customers of the procurement process.

Market Research in Contracting

Market research became a statutory requirement with the passage of the Competition in Contracting Act (CICA) of 1984. The Act specifically states: "In planning for the procurement of property or services, an executive agency shall ..use advance procurement planning and market research...." [12] Market research is intended to offer an opportunity to reduce barriers to competition by improving the information available to the contracting officer during the acquisition planning phase. The statute makes market research the central function in both achieving competition where possible and justifying the circumstances when it is not. [13]

In a recent study, a definition of market research was proposed as, "the collection and analysis of data to improve the quality of specific decisions which must be made within the existing framework of the procurement process." [12] This definition recognizes that there are many aspects of the procurement process that stand to be improved through market research.The study also presented both a narrow view and a broad view of market research pertaining to the Federal procurement process, and advocates adoption of the broad view. [12] "One, the narrow view, holds that the purpose of market research is merely to identify potential sources of supply. The other, the broad view, holds that market research involves far more than identification of potential sources of supply. In fact, the broad view is that the requirement involves understanding the market place and conducting the methodical research that is often times necessary to develop that understanding.

It is clear that a thorough market research capability developed within the Federal procurement system would substantially strengthen the ability of the Government to use and enhance the purchasing process more effectively, including, but not limited to, generating competition [11]

Stewart delineated five principal elements of an effective market research program based on an analysis of literature and observations of both Government and private industry practices: (1) criteria for project selection, (2) proper research and analysis skills, (3) a methodical approach, (4) timely information, and (5) effective communication of findings. [12]

Application of the Taxonomy in Market Research

Implementation of the taxonomy of goods procured by the Federal Government would facilitate market research in several respects. The taxonomy would first be operationalized, with all goods procured by the Federal Government classified. Then the classification scheme could serve as the basis for organizing market research. Research on the market could be done on a category-by-category basis, providing an organizational framework for systematic study. Elements of the scientific-theoretical usefulness of the taxonomy described earlier would be applied in market research. If market research were conducted along the lines of the categories of the taxonomy, literature reviews would be made easier because information on the market could be accessed by the category to which an item belongs. The categories would serve as the bases for conducting and reporting research studies to facilitate their comparison. Observations of goods within individual categories may be generalized to other goods in the same categories. For example, suppose that personal computers and ship positioning computers were both identified to the advanced category of goods. Perhaps goods in this category would be

characterized by a high degree of maintenance. Observations of the successful warranty terms or maintenance contracts used in the more commonly procured personal computers could be generalized and used when buying the less frequently purchased positioning computers.

Areas where greater research is needed may be exposed. At the present time, there is no framework consistently used throughout Federal procurement for the accumulation and storage of market research data. Adoption of the taxonomy could provide a consistent approach for accumulation of information on the market.

As discussed earlier, Stewart identified five principal elements of an effective market research program. The taxonomy would facilitate several of these elements. The first element, criteria for project selection, would be enhanced by the taxonomy because one of the criteria for project selection should be simply whether or not there is any existing information available on the project at hand. For example, a buyer has a requirement for a pneumatic valve. Before initiating a market research project, the buyer could access a data base by the category of the valve, perhaps moderate, to see if there is any market research information already available. If so, the information could be used, and no new project would be required. If not, a market research project may be initiated. The taxonomy would provide a means for searching for, and utilizing, existing information, or confirming that none exists.

Another element of an effective market research program is a methodical approach which the taxonomy could provide. Market research could begin with the simple or complex category, or any category between the two. Research could be conducted on that category on a consistent, organized and continuous basis, methodically building the knowledge base. Framing market research in this manner would prevent duplicating efforts or missing important information.

Market research information would be provided in a more timely fashion because the taxonomy would allow cataloging of the information. If a buyer needs information on a moderate good, perhaps a galley oven, information could be quickly retrieved by reviewing the data base accumulated under the heading of the moderate category. This would allow quick information retrieval, and prevent having to start at the beginning with each market research project.

Finally, the effective communication of findings would be simplified by the taxonomy. Again, this is a function of indexing market research along the categories of goods. This would provide those who need the information an effective access mechanism to the information. Organizing market research around the taxonomy would allow findings to be related back to the body of knowledge in the same manner, encouraging more effective communication of findings.

From the macro perspective, market research framed by the taxonomy may reveal certain categories of goods that are particularly well-suited for procurement from small business, which should then be targeted as such. On the other hand, market research may reveal a category of goods where there is little small business participation. Market research could then be initiated to identify and remove the barriers to small business participation. Principles discovered in studying categories where small business participation is exemplary could be emulated in areas where there has been little success. For example, suppose market research reveals that there is a large number of small businesses succeeding in the advanced category of goods, but few in the less complex moderate category. It may seem unusual that small businesses are succeeding in the more complex category rather than the simpler category. Study could then be conducted to determine the reasons for the difference. Perhaps the difference is that in the advanced category, goods are characterized by a higher degree of technical complexity than the moderate category, but less capital investment is required. It may be discovered that small businesses are very skilled technically, but they do not have access to capital for the equipment required for goods in the moderate category. A concerted effort could then be made to provide access to capital for small businesses in order to succeed in the moderate category of goods.

Organizing market research in relation to the taxonomy may force recognition of characteristics shared by goods from seemingly different industries for comparative purposes. From the perspective of an individual procurement, or micro view, the taxonomy could provide access to market research information based on the category of the item being procured. For example, a particular procurement may appear

unique, with only one contractor capable of responding to the need. Since goods are classified according to inherent characteristics deemed important in the buying process, rather than physical characteristics, the taxonomy may provide insights not otherwise considered. Based on the category to which the item being procured belongs, market research centered around the taxonomy may reveal other companies that are capable of manufacturing the item.

In addition to enhancing market competition, market research could also provide access to information required for individual negotiations, including the state of technological change, manufacturing processes, warranty practices, and factors affecting prices.

For an organization buying bulk items, such as fuels, market research may reveal lower priced product substitutes such as another grade or type of fuel. Market research may provide quick access to price trends so that an organization can time their buys accordingly, such as making a large bulk purchase instead of a series of small buys as prices are increasing. It may identify goods in markets which are likely to be volatile, or indicate the likelihood of strong or weak commercial demand for the goods, assisting in procurement planning.

In summary, implementation of the taxonomy of goods would provide several benefits in the area of market research. In addition to identifying sources of supply by individual category to enhance competition, it could also serve as the framework for conducting methodical research, and enhance understanding of the market. The taxonomy would be a tool used by the procurement workforce that would make market research a viable process.

Procurement Regulation

Introduction

Within the field of Government contracting, Robert Judson's profile of the acquisition environment, serves as the basis for promising taxonomical applications. "Often, critics of the acquisition process assume that the characteristics of purchasing ordinary consumer goods can be readily transferred to the acquisition of unique systems. It is the author's hope that this profile will suggest restraint, in some small way, in the mad dash to legislate and regulate the acquisition of uncertain products as if such undertakings were simple variations of the consumer purchasing process and only need to be pressed by law and regulation into that familiar mold." [14]

The obvious implication is that buying commercial, perhaps simple, items at one end of the spectrum is a different process than buying uncertain, perhaps complex, items at the other end of the spectrum. These differences should be recognized not only in procurement laws and regulations, but in policies and procedures as well. These separate areas of application are distinct, however they do share the common threads of shaping and guiding the procurement process, some more rigidly than others. As such, the logic underlying the usefulness of the taxonomy is similar, as are the benefits, in all of these areas. These areas will be collectively referred to as regulation.

The Judson profile suggests that regulations are being written for unique items, such as major weapon systems, as if they were simple commercial items. This idea can be taken a step further. There are laws and regulations in existence that have been written with the purchase of complex items in mind that are needlessly applied to the purchase of simple items, creating an unnecessary administrative burden.

Application of the Taxonomy in Procurement Regulation

The taxonomy of goods procured by the Federal Government could prove to be a very useful tool in shaping procurement regulation. If all goods were identified to their respective categories, ranging from simple to complex, regulation could be tailored and applied to individual categories. The possibilities of such a system are most apparent when comparing the extreme categories of simple and complex goods. However, refinements could also be made between the middle categories which, when applied Government-wide, would be extremely beneficial.

By viewing goods that the Government buys in separate categories rather than as one large homogeneous group, a relationship between the characteristics of the products within each category and appropriate regulation could be determined. Refinements could be made between individual categories as well as within the extreme ends of the simple-to-complex scale. For example, at the complex range of goods, such as major weapon systems, two programs may be

classified as acquisition category I programs because of the dollar value of the programs. As such, the two programs would be subject to the same regulation. The taxonomy may reveal that the goods procured in one program belong in the advanced category rather than the complex category, thereby allowing some relief or additional streamlining of the acquisition process. A possible scenario for this would be a major non-developmental item (NDI) program compared to a major research and development program. Within a single major weapon system, some of the items procured may be complex, while the taxonomy may indicate that other items within the program are more appropriately classified as simple, basic, or moderate, allowing for less regulatory control.

In these times of declining budgets in the defense industry, the Government must pay close attention to the defense industrial base. The taxonomy of goods procured by the Federal Government could help shape and implement a comprehensive industrial base policy. It could highlight the category or categories of goods where there are few sources of supply, perhaps a key link to the industrial base. It may show that there is a high degree of homogeneity in all but one of these categories, suggesting that concern for a diminishing industrial base need only be directed towards a single category. Or perhaps, although there are few producers in a particular category, the number of goods in the category is few, with no anticipation of increasing needs. These circumstances may lead to adoption of a policy that allows market forces to take their course.

Another possibility is that the taxonomy reveals categories characterized by different degrees of customization. Customization may be a key link to the industrial base. Goods with little customization seem likely to be commercial goods, which translates to alternate markets for companies. If there is little customization in three of the categories of goods, it may indicate that these categories have strong commercial markets, meaning there is no need for concern with the industrial base in these categories. A fourth category of goods may have a medium amount of customization, but many sources of supply, again indicating little need for concern with industrial base policy since there are many sources. However, the fifth category of goods may be made exclusively for the Government. In this case, the Government's industrial base policy may be to take a hands-off approach towards the first four categories. For the fifth category, the Government may need to take definite actions to maintain an essential industrial capability.

As a way of assisting firms that make that fifth category of goods, actions that would assist the industry could be linked to that category of goods, providing for concentrated, efficient action. For example, in order to strengthen firms making this category of goods, the Government may decide to liberalize independent research and development (IR&D) funding and link it to commercial product development, specifically for firms making this category of goods, thereby helping to maintain their strength.

An example of the concept of linking research funding to commercial product development is the Small Business Innovative Research (SBIR) program. Under legislation being developed, SBIR program funding would have a stronger link to commercial product possibilities. An important consideration in the evaluation for funding will be based on the applicant's plans to market the product commercially. [15] The taxonomy would allow this concept to be linked to the category of goods where it is most needed, rather than across the board, thereby maximizing the benefits of limited resources.

Another situation may be that market research done on this category of goods has revealed impediments to business operations such as profit considerations focused too heavily on capital equipment investment, or excessive use of design specifications. A concerted effort could be directed towards manufacturers of this category of goods to improve the circumstances. Perhaps unique considerations must be made in determining profit objectives, such as shifting emphasis from capital equipment investment to commercialization potential, or a special emphasis on eliminating design specifications, which tend to inhibit innovation and create inefficiency. Perhaps this category of goods may be targeted for multiyear contracting. In essence, the Government could develop and tailor policies taking into account information revealed from implementation of the taxonomy.

Implementation of the taxonomy of goods could provide a sound framework for selectively applying regulation. In many cases now, regulation is either applied across all procurement or linked artificially to selected dollar values. For example, small purchase procedures are presently limited to procurements under $25,000. It may be

more logical to link small purchase procedures to the characteristics of the goods rather than dollar value. The practice of allowing oral solicitations can be more logically linked to the characteristics of the goods, such as customization or sources of supply. Oral solicitations would be called for when an item is not customized, because there would be no need for detailed specifications, and there would probably be a commercial market for the item. This combined with many sources of supply would indicate that market forces set a fair and reasonable price for the item. Allowing oral solicitations where appropriate based on the characteristics of the goods would save the time and cost of creating formal written solicitations.

Small purchase procedures are basically designed to streamline the procurement process, reduce administrative burden, and promote efficient and economical practices. Small purchase procedures balance the need for control with efficiency and low administrative costs. The success of these procedures could more logically be linked to the level of complexity, customization, documentation, or item attention rather than the dollar value. The taxonomy could identify the category or categories of goods that have the characteristics which lend themselves to streamlined procurement procedures.

Procurement Training

Introduction

"A strong and viable training and educational program is fundamental to strengthening the DoD's acquisition process." [16] Presently, training systems are very fragmented and diffused. Training and education need to be taken more seriously and managed coherently. [17] When many thousands of people must make contracting decisions, and wrong decisions can cost billions, the need for quality procurement training is overwhelming. "We need better curriculum research technologies to match remedies to troubles." [18] The taxonomy could be an innovative tool for matching remedies to troubles.

Application of the Taxonomy in Procurement Training

The first problem encountered in developing training courses is obtaining sufficient task-descriptive data in a form that will permit the appropriate design and conduct of training. The procedures the person is expected to follow, the equipment and tools required, and the conditions of the job must be identified. [8]

The taxonomy could be the tool needed to obtain task-descriptive data in an appropriate form. It could be used to improve procurement training and education by linking and prioritizing the skills that are important in buying specific categories of goods. The procedures the person is expected to follow, the competencies required, and the conditions of the job can be more accurately identified, and training could then be more accurately tailored to the student's needs.

The taxonomy would first identify the different categories of goods. Following classification, the individual categories would be studied to identify the specific competencies required in procuring those goods. These competencies encompass two aspects, both the task or skill itself, and the degree of skill required in performing the task. For example, one buyer may perform cost analysis occasionally on a relatively simple level, while another may be required to perform relatively complex cost analysis on a regular basis. Both need cost analysis skills, but at different competency levels. An important insight the taxonomy could provide that is not otherwise evident today is the combination of skills, and the level, appropriate for a given training course.

A look at the some of the individual characteristics may help demonstrate the insights that may be gained from the taxonomy. The first characteristic to consider is change. The opposite ends of the scale for change are very low rate of technological change and very high rate of technological change. An examination of the degree of change, and the resulting implications, in the category of goods that the buyer purchases would allow tailoring of the training provided to that person, and others who procure the same category of goods. For example, goods with a very low rate of technological change may belong to the simple category. A very low rate of technological change could indicate that competency in contract changes is a low priority. On the other hand, goods with a very high rate of technological change, possibly the complex category, may call for a high priority in contract modification, configuration change management, equitable adjustment pricing techniques, and market research skills.

Continuing with this example, the customization characteristic in the simple category of goods may be scaled as no amount of customization, and the complex category may

be scaled as made exclusively for the Government. The scale of no amount of customization may indicate that buyers do not need skills in the proper selection of specifications. Indirectly, this may imply a low priority on cost analysis skills, formal source selection planning skills, and negotiation skills since the buyers would most likely be dealing with price competition. The other end of the customization scale would call for a high degree of competency in these skills.

Benefits of the Taxonomy in Procurement Training

It is not suggested that the taxonomy of goods is the cure-all for procurement training and education problems. It will not magically eliminate training backlogs and increase resources. However, the tailored training approach encouraged by the taxonomy would enhance competency and skill development and provide task-descriptive data for designing courses. Case studies, exercises and simulations used in teaching could be closely tailored to the students' own situations. Innovative techniques such as the taxonomy, which assess the complexity of goods, are important in giving the issue more visibility.

The taxonomy addresses directly the need to establish training and education requirements based on the level of complexity of the duties carried out by individuals. And as pointed out by one of the contracting experts interviewed for this research: "It might also suggest the need for training in areas not now covered by the more or less standard menu of courses offered."

The level and combination of skills needed in job performance, as identified by the taxonomy, could be used, perhaps in conjunction with the Federal Acquisition Institute (FAI) training blueprints, to develop a more effective and efficient Federal procurement training system. Viewing the spectrum of goods in this manner would allow procurement training to be tailored directly to the needs of the buyers. It provides a means for prioritizing training needs in order to get the maximum benefit from the limited resources that are available.

RECOMMENDATIONS

Insights revealed by the taxonomy of goods procured by the Federal Government should be used to develop guidance, not rigid rules. The Federal procurement process is already burdened with too many rules and regulations. The consequence is a restrictive procurement process that dictates procedures that apply in all situations, removing any room for flexibility and individual judgment. The taxonomy should be used to develop guidance and general principles that procurement managers can use to support individual decisions.

As more goods are classified, application of the taxonomy in market research should be refined to incorporate new insights. The characteristics of the goods that are important in this application may become evident, requiring the addition or deletion of the characteristics used for classification. The taxonomy may help to identify information not yet considered important, such as barriers to competition. The very nature of the way the Government views and conducts market research may change as a result of further development of the taxonomy of goods procured by the Federal Government.

Application of the taxonomy in procurement regulation should be further expanded upon. Procurement regulation is far-reaching and covers a vast portion of the procurement process. This study has described how the taxonomy could be applied in several areas of procurement regulation. There are many more aspects of procurement regulation that should be explored and developed.

Application of the taxonomy in procurement training and education should be refined as more goods are classified. The way Federal procurement training and education is conducted may change as a result of the insights provided by application of the taxonomy. New light may be shed on what the training priorities should be. It is natural that the application of the taxonomy will need to be refined as new insights are gained.

Future efforts should continue to examine potential applications of the taxonomy. This research effort has attempted to identify potential areas of application and suggest potential benefits to be gained from the taxonomy. In doing so, the general thought process or logic of how the system could be used was presented, citing potential implications. This process should be continued, perhaps by taking a single application, in conjunction with a single category of goods and examining the full range of insights that may be drawn from that application.

FIGURE 1

CHARACTERISTICS: DEFINITIONS AND SCALES

Complexity describes the good's technical intricacies. The degree of complexity may be in terms of the skill and expertise needed to produce the good. Another view is whether the good is a system, sub-assembly, component, piece part, or raw material. A 1 indicates little or no technological complexity with 5 being very high complexity.

1 Very low technical complexity
2 Low technical complexity
3 Medium technical complexity
4 High technical complexity
5 Very high technical complexity

Customization is the degree to which the good is manufactured to the buyer's specifications. Some goods have no amount of customization while others are produced exclusively for a buyer. Goods that are not customized should be scored 1 with those developed exclusively for the Government scored 5.

1 No amount of customization
2 Low degree of customization
3 Medium amount of customization
4 High amount of customization
5 Made exclusively for the Government

Maintainability refers to the amount of maintenance considerations associated with the good. In other words, how frequently, if at all, is maintenance is required on the good. Some goods are virtually maintenance-free while others require a great deal of maintenance throughout their lives.

1 No maintenance required
2 Low maintenance requirements
3 Medium maintenance requirements
4 High maintenance requirements
5 Very high maintenance requirements

Unit cost is the good's cost to the buyer. Generally speaking, as a good becomes more unique to the buyer's requirement, the unit cost is increasing. Use 1 for low unit cost and 5 for very high.

1 Very low unit cost
2 Low unit cost
3 Medium unit cost
4 High unit cost
5 Very high unit cost

Documentation is another characteristic external to the good yet many times a necessary part of it. Frequently the Government requires substantiating documentation in the form of drawings, technical manuals, and certifications for some types of goods while for others little at all is required. A 1 would indicate a good purchased with no accompanying documentation while 5 is for goods accompanied by drawings, technical manuals, etc.

1 No associated documentation
2 Low amount of documentation
3 Medium amount of documentation
4 Great deal of documentation
5 Very high amount of documentation

Item attention given by the buyer refers to single-item versus volume or mass buying. When a buyer deals with small dollar-value items like common bolts and rivets, the focus is on a mass quantity of these types of goods. Contrast this with the acquisition of a F-14 aircraft where the buyer's attention is focused on a single item.

1 Complete volume-type attention
2 Mostly volume-type attention
3 Either volume or single item attention
4 Usually single-item attention
5 Always single-item attention

FIGURE 1 (cont.)
TAXONOMY

	Avg Value	Categories: Simple (1.00-1.80)	Basic (1.81-2.60)	Moderate (2.61-3.40)	Advanced (3.41-4.20)	Complex (4.21-5.00)
Complexity						
Customization						
Maintainability						
Unit Cost						
Documentation						
Item Attention						
Overall Score						

KEY:
+ : UPPER END OF THE CATEGORY
0 : MIDDLE OF THE CATEGORY
- : LOWER END OF THE CATEGORY

BIBLIOGRAPHY

[1] Wenger, Brian L., "A Taxonomical Structure for Classifying Goods Purchased by the Federal Government," Masters Thesis, Naval Postgraduate School, Monterey, California, December 1990.

[2] Prendergast, John J., "Application of a Taxonomical Structure for Classifying Goods Procured by the Federal Government," Masters Thesis, Naval Postgraduate School, Monterey, California, December 1991.

[3] Park, Steven A., "The Possibility of a Contracting Science," Masters Thesis, Naval Postgraduate School, Monterey, California, December 1986.

[4] Hunt, Shelby D., Marketing Theory, Homewood, Illinois, Richard D. Irwin, Inc., 1983.

[5] Roback, Herbert, "Towards More and Better Procurement Research," Defense Management Journal, July 1975, pp. 4-6.

[6] Williams, Robert F. and Arvis, Paul F., "The Possibility of a Contracting Science," Proceedings Federal Acquisition Research Symposium, Richmond, Virginia, November 1985, pp. 26-30.

[7] Miracle, Gordon E., "Product Characteristics and Marketing Strategy," Journal of Marketing, V. 29, January 1965, pp. 18-24.

[8] Fleishman, Edwin A. and Marilyn K. Quaintance, Taxonomies of Human Performance: The Description of Human Tasks, New York, Academic Press, 1984.

[9] Sokal, Robert R., "Classification: Purposes, Principles, Progress, Prospects," Science, V. 185, No. 4157, 27 September 1974, pp. 1115-1123.

[10] Fleishman, Edwin A., "Systems for Describing Human Tasks," American Psychologist, V. 37, No. 7, 1982, pp. 821-834.

[11] Sherman, Stanley N., Government Procurement Management, Wordcrafters Publications, Germantown, Maryland, 1991

[12] Stewart, Richard L., "Market Research for Effective Competition in the Federal Procurement Process," Masters Thesis, Naval Postgraduate School, Monterey, California, December 1987.

[13] Mulhern, John J., "Policy Guidance on Market Research for Contracting Officers," National Contract Management Journal, V. 24, No. 2, 1991, pp. 33-39.

[14] Judson, Robert R., "A Profile of Acquisition Environments," Contract Management, December 1986, pp. 14-15.

[15] Gupta, Udayan and Saddler, Jeanne, "Enterprise: Bill Likely to Put $1 Billion Into Small Firms' Research, Expanded Program Would Sharpen Focus on Commercial Possibilities," The Wall Street Journal, 29 September 1992, p. B2

[16] Defense Systems Management College, The Acquisition Enhancement (ACE) Program Report II, Vols. 1 and 2, Fort Belvoir, Virginia, December 1986.

[17] Mavroules, Nicholas, "Creating A Professional Acquisition Work Force," National Contract Management Journal, V. 24, No. 2, 1991, pp. 15-23.

[18] Crawford, C. C., Siegel, Gilert B. and Kerr, John A., "Learning Needs of Contracting Personnel," National Contract Management Journal, V. 23, No. 2, 1990, pp. 55-66.

SIMULATED NEGOTIATIONS:

A MEASURE OF THEIR EFFECTIVENESS ON NEGOTIATED OUTCOME

Dr. David V. Lamm
Lieutenant Robert J. Bennett, SC, USN
Naval Postgraduate School
Monterey, CA 93943

ABSTRACT

Negotiations play a significant role in the acquisition of goods and services not only in the Federal Government but also within the commercial world. The importance of procurement negotiations suggests the need for a continuing effort to improve negotiation effectiveness and thereby improve the results attained through negotiations.

This research examined the effect on a negotiated outcome if buyers engage in preparatory <u>simulated negotiations</u>. If it was found that simulated negotiations resulted in a significantly improved outcome during the actual negotiation, then the conduct of such preparatory simulated negotiations could enhance negotiator effectiveness. The research question was: What are the key factors associated with the use of simulations in preparation for actual negotiations and how might these factors be used to enhance the preparation for negotiation?

One hundred and thirty nine negotiations involving (1) Department of Defense (DOD) buyers, (2) industry contractors, and (3) student participants were conducted at three colleges, four DOD contracting activities and four defense contractors' facilities. The data collected from these negotiations included the prices negotiated and a qualitative assessment based on the respondents' answers to a series of questionnaires.

Based on an analysis of these data, it was concluded that buyers engaging in simulated negotiations improved the negotiation outcome. The study also reports the key differences concerning the utility of simulated negotiations among the three test groups.

INTRODUCTION

Negotiation is of crucial importance in DOD acquisitions. The selection, training, preparation and performance of contract negotiators have been continuing concerns, as indicated by the <u>Report of the Commission on Government Procurement</u> in 1972. [1] In a recent study, the U.S. Merit Systems Protection Board (MSPB) highlighted the ability to conduct negotiations as one of the essential areas needing additional training in order to improve the quality of the acquisition workforce. [2]. Preparation is considered by a number of authors and researchers to be the key element of negotiator effectiveness. Simulated negotiations have been found to be potentially prominent among various preparation techniques. Accordingly, it was the purpose of this research to explore, through experiment, the use of simulated negotiations by the buyer and to determine what effect, as measured by price, the use of this technique had on the negotiated outcome. Additionally, the research sought to identify those factors in the simulated negotiation process which enhanced the preparation for actual negotiations. This research did not attempt to determine the effect of other variables of negotiation effectiveness, such as structural, physical, issue, or other negotiator variables. It also did not attempt to measure the effects of personality characteristics on the negotiated outcome.

PREPARATION

It has been said that at least 90 percent of success in negotiations is due to thorough preparation. [3] One of the most important points

of negotiation is that the team that obtains more of their objectives after a negotiation is generally the one that was better prepared. The reverse is also true. If an opponent comes out best at the end of a negotiation, it is usually because the negotiator was not prepared.

According to William F. Morrison, "If a picture is worth a thousand words, then one role-play will prevent thousands of mistakes." [3] The essence of this quote is to practice the negotiation in order to avoid mistakes during the real thing. Morrison goes on to suggest that the negotiator ask a peer or their boss to take the part of the opponent and to practice the negotiation with them in a role play. The purpose would be to find all of the weak points in the negotiator's plan. He further suggests that an even better idea would be for the negotiator to find a person in their organization who performs the same functions as the person with whom they will be negotiating. For example, if the negotiator is a buyer, he should ask a seller in their company to role-play with them. The rationale is simple. In general, people in purchasing do well in performing the role of a buyer, but not very well as sellers because they approach the seller's position from a buyer's perspective. Their value system is not the same. The converse also holds true. [3] Simulated negotiations have long been used in preparing for labor contract negotiations. Dale Yoder writes that "... both firms and unions use workshops and practice sessions--'simulations,' in more sophisticated terms--with mock sessions and role playing to provide training and preparation for their negotiations." [4] Forsini, Shaw and Blake reported that, through the simulated negotiation experience, union representatives become aware of many potential issues and controversies that are not readily apparent on the surface of a negotiating situation. Thus, they become forewarned and prepared to handle these situations. [5]

Discussions during this research effort with purchasing and marketing representatives from a number of firms who handle military and commercial sales revealed a wide variety of techniques when preparing for negotiations. These techniques range from meetings to discuss and review a company's proposal to the other extreme of actually conducting a "mock" simulated negotiation. The list below summarizes some of the preparatory techniques used by five different manufacturing firms in preparing for negotiations. While this list is by no means complete, it does represent some of the more popular preparatory techniques used by the industrial firms contacted.

Preparation Techniques

* Meeting between procurement supervisor and negotiator(s) to review proposal.

* Publicly available video tapes on negotiations.

* Mock negotiation case studies.

* Video recording of mock negotiation cases.

* Negotiation seminars.

* Dry run of negotiation with manager playing the role of "devil's advocate."

* Tiger team approach.

* Simulated negotiations.

At a minimum, all the firms conducted discussions to review a company's proposal. These discussions could be as simple as deciding the **targets** of the firm (maximum, minimum, and objective positions) to mapping out the strategy and tactics that will be used during the negotiation. Frequently, these discussions are the starting point in the preparatory process. Beyond these discussions, some firms take the process one step further and use a **Tiger Team** approach or go through an actual dry run of the negotiation with the manager playing the role of "devil's advocate." In the Tiger Team approach, a group of negotiators frequently **brainstorm** different strategies and tactics to be used and may also practice questioning techniques in an informal sort of role play. Building upon this approach, the negotiating team may conduct a **dry run** of the negotiation. In the dry run, the negotiators begin with their opening moves and the strategy and tactics the team intends to employ. The manager or some other team member plays the role of the **devil's advocate**, asking probing questions and trying to find flaws in the negotiators' logic. Role-plays generate

considerable enthusiasm and contribute to building a team. Those in the role-play generally exert themselves to prepare the case because they want to appear professional in front of their peers. As a result, the team members learn a lot about the process of negotiation. [3] Another extension of this process is the use of a **Murder Board** which consists of senior purchasing, materials management, finance, manufacturing, quality, engineering, and general management personnel. Like the dry run approach, the negotiating team presents its agenda, objectives and tactics for the forthcoming negotiations. Members of the murder board then dissect the negotiating plan in an effort to identify avoidable problems. [5] A final extension of this preparatory process is for the negotiators to conduct a formal mock or **simulated negotiation** similar to the one previously described. In this simulation, company negotiators play the different buyer and seller roles against one another and actually go through the negotiation from start to finish. In some cases, the negotiation is video taped and then later reviewed and critiqued by the group. Video taping was found to be an extremely valuable, low cost preparatory tool for effective negotiation. Use of the video system allows the negotiators to retrospectively evaluate their strengths and weaknesses, to evaluate their negotiation strategy and to see what their "body language" was saying. In some cases a negotiator would be saying one thing, thinking they were coming from a position of power, when in fact their body language was saying quite the opposite.

The simulation technique is valuable in the preparation for negotiations because it allows the players to act out the entire negotiation before it takes place. The process helps the negotiators see what lies before them in the coming negotiation and presents it much more vividly than if they merely talked about it. This method also gives the negotiators a chance to try something without the risk of failure. Simulated negotiations permit the negotiator to bring into focus any important elements that may have been overlooked or ignored in their original assessment of a proposal. Furthermore, the technique facilitates making corrections in their preparation because it allows the negotiator to put themselves across the table and see the other person's point of view before the negotiation.

Brosius and Erickson conducted an experiment in 1974 to measure the effect of simulated negotiations on final negotiated results. [6] They used DOD procurement careerists as participants and divided them into two groups: experimental and control They defined negotiated outcome as the price the buyer would pay. They statistically compared the price that the experimental-group buyers negotiated in the "actual" negotiation with the price that the control group negotiated.

RESEARCH DESIGN

The design of the instant research evolved from a field experiment conducted at the Naval Postgraduate School (NPS) This field study was based on the test structure employed by Dr. David N. Burt to measure the effect of simulated negotiations as a preparation technique on negotiation effectiveness. [7] This study was constructed in much the same manner as the Brosius and Erickson study. Control-group participants playing the role of the buyer (B_1) negotiated with participants playing the role of the seller (S_1) in the "actual" negotiation. Control-group buyers negotiated only once in the "actual" negotiation. The outcome of the negotiation was the final negotiated price of the contract. Next, experimental-group participants playing the role of the buyer (B_2) engaged in simulated negotiations with participants playing the role of the buyer's supervisor (boss) (B_3) before "actual" negotiations with the seller (S_2). Analogous to the control group, participants playing the role of the seller negotiated only once in the "actual" experiment. One cycle of the experiment required five individuals. A summary of the assigned roles is provided as follows:

Group	Simulated Negotiation	Actual Negotiation
Control	None	B_1 against S_1
Experimental	B_2 against B_3	B_2 against S_2

If the mean price negotiated by the participants playing the role of B_2 was statistically significant from the mean price negotiated by participants playing the role of B_1, it could be concluded that simulated negotiation affected

negotiation effectiveness, i.e., price negotiated, when employed by the buyer and not by the seller as a preparation technique for negotiation. The instrument used to generate both the simulated negotiations and the actual negotiations was a structured, role-playing contract negotiation case used by Professor Burt in his experiment. [8]

Individuals who served as subjects in the NPS experiment were third quarter contracting students in the Contract Pricing and Negotiations course. Additionally, the experiment used questionnaires and personal interviews with the experimental buyers to measure their perceptions of how simulated negotiations affected their performance in the actual negotiation. The rationale for the questionnaire was to obtain a qualitative measure of the simulated negotiation effect. One questionnaire was administered to the buyers after the simulation round. Following the actual negotiation, a second questionnaire was completed, each buyer was interviewed and a buyer group debrief was conducted. It is to be noted that the control and experimental groups are not directly linked together for the purposes of comparison. Rather, a number of independent control groups were run in order to establish a relevant "price range" from each of the negotiations. This served to eliminate individual differences between buyers and sellers in each round.

The experiment was conducted in the following sequence of events with the roles defined below:

Hour #1
The experimental buyer (B_2) and the boss(B_3) negotiated and reported the results. The boss then gave feedback to the buyer.

Hour #2
The control buyer (B_1) and the control seller (S_1) negotiated and reported the results.

After the boss had concluded the feedback session, the experimental buyer completed a post-simulation questionnaire and prepared for the "actual" negotiation.

Hour #3
Buyer B_2 and the experimental seller (S_2) negotiated and reported the results.

Hour #4
After B_2 and S_2 negotiated, the experimental buyer completed a post-negotiation questionnaire and participated in an interview session.

Each of the roles were distributed to the participants at least 24 hours prior to beginning the experiment in order to study the role and prepare a negotiating position. Care was taken to ensure that sellers **NOT** know whether they were negotiating with a control buyer or an experimental buyer as it was perceived this would affect their motivation during the experiment.

RESEARCH EXPERIMENT

The selection of participants to play the roles was accomplished by soliciting participation from three different groups: (1) contracting/negotiation students, (2) Government contracting personnel, and (3) industry contracting personnel who interface primarily with Government organizations. The student groups were comprised of contracting students at NPS and students in negotiation courses at the University of San Diego and the University of Southern California. A total of 133 students participated in the experiment. While some of the students had limited contract negotiation experience, the vast majority of them had no formal negotiation experience other than in-class exercises. The case used for the experiment was relatively uncomplicated and could be easily handled by even the novice negotiators. The military and commercial organizations utilized in this research are all located on the West Coast in California, and are sufficiently large and experienced in negotiating DOD contracts to employ contract negotiators, contracting officers, contract administrators, and/or cost-price analysts experienced in negotiating contracts. Four military activities and four commercial corporations were used in the study.

ANALYSIS OF NEGOTIATED PRICE

A total of 226 individuals from the three schools (133), four Government activities (52) and four commercial corporations (41) participated in the experiment. One hundred thirty-nine rounds of negotiations were conducted. Nineteen resulted in an impasse (six in the simulation round, nine in the actual round and four in the

control round) and were discarded. The price outcome of the remaining 120 rounds of negotiations consisted of the dollar amounts negotiated and agreed upon by each buyer-seller pair, including the simulated negotiation between the buyer and the boss. All of the data are summarized in Table I and include the mean price negotiated, the standard deviation, and the number of elements in each population.

The results from the experiment indicate that the final price was $57,483.10 less (better from the buyer's perspective) when simulation had been used. The mean price negotiated was $2,239,458.70. and thus resulted in a 2.5% decrease in price. Hence, simulated negotiations as a preparation for actual negotiations proved to be beneficial in this experiment and improved the negotiated outcome for the buyer. However, when looking at each group individually, all of the results were not the same. While the student and industry participants (as a group) who engaged in simulated negotiations obtained a lower price than their control group counterparts, the Government participants obtained a higher price. These results are summarized in Table II.

The student group had the biggest decrease in price (4.8%) when compared to their control group counterparts. and industry participants achieved a 3.0% reduction in price. For these two groups, the simulation appeared to be a beneficial preparatory technique. In contrast, the Government participants who engaged in simulations prior to their actual negotiation had a 3.9% increase in price when compared to their control group. This suggests that the benefits of simulation as a preparatory technique may not be universal. One possible explanation for the dissimilar results between the groups may have been due to the difference in attitude of the participants. In general, more willingness and even anxiousness, was noted on the part of students and industrial participants to see how well they could perform having done the simulation. There also appeared to be a degree of competition among the students and some of the industrial participants. These groups appeared to have a keen interest in seeing how they "stacked up" in comparison to other participants. There also appeared to be an element of wanting to appear fully competent and professional in front of a peer, an instructor, or a supervisor. This is not to say that these elements were not present in any of the Government participants. On the contrary, some of the Government participants appeared to be very aggressive and competitive during the experiment. However, as a group, these tendencies may have been mitigated by concern over their ever growing workload or a feeling that "the results were of little or no consequence" to them. Therefore, some of the Government participants may have given their second play in the actual negotiation less than their best effort. Furthermore, as a group, the Government participants reduced the price from the simulation round to the actual negotiation by 4.1%, the largest reduction of any of the groups. Therefore, there may have been a feeling on the part of these buyers that the price was lower than what they received in the simulation round and therefore was "good enough." One of the Government participants said, "I knew this price would be acceptable, because my boss and I negotiated a higher price during the simulation. I figured that if I came home with anything less than that (the simulation price) would be good."

ANALYSIS OF QUESTIONNAIRE RESPONSES

The post negotiation questionnaire consisted of 20 questions asked of each experimental buyer (B_2). A Likert Scale was used for the first 14 questions (a five point scale ranging from strongly agree to strongly disagree). Table III summarizes the average response rates for each of the Likert Scale questions asked regarding the usefulness of the simulated negotiations.. It is interesting to note that the student and industry groups appear to correlate more closely than the Government group. Intuitively, it was expected that there would be a higher correlation between the industry and Government groups because of the greater similarity in their demographics.

Table IV summarizes the most often cited responses to the question which asked: Compared to the simulation, how did you feel during the actual negotiations? The question had twelve adjectival qualities and asked the respondents if they felt MORE, EQUALLY, or LESS on each during the actual negotiation.

STRENGTHS AND WEAKNESSES OF SIMULATED NEGOTIATIONS

Two of the questions asked the respondents

their opinions and perceptions concerning the greatest strengths and weaknesses of the simulated negotiations. These are summarized below.

Strengths

- enabled them to evaluate their overall position and revealed weaknesses in their arguments.

- revealed potential seller arguments and helped them anticipate points of difficulty. In doing so, it enabled them to formulate counter arguments and to better anticipate questions in the "real" negotiation.

- enhanced their knowledge of the facts and how to deal with then during the nego .ion. One respondent claimed that the simulated negotiation helped him, "get comfortable with the numbers and the situation itself."

- enabled them to focus in on issues not previously considered and emphasized the relevant facts. In some cases, the simulated negotiation helped them adjust or "tweak" their focus appropriately.

- enabled them to brainstorm different ideas and to prepare for different contingencies. It also enabled them to get alternate strategies for use during the actual negotiation.

- enabled them to try out different ideas, strategies and tactics that they would not otherwise have tried in a risk free environment. The simulated negotiation helped them to determine the effectiveness of their strategy and tactics. It also allowed them to make mistakes and to get feedback from their mistakes.

- enabled them to practice what they were going to say from start to finish. It also enabled them to express their ideas to ensure that they were understandable. The simulation was like a rehearsal of what may happen during the actual negotiation.

- reinforced the strengths of their position and confirmed their planning. It also helped them to solidify their arguments and to clarify their objectives and the points they wanted to make during the actual negotiation.

- gave the participants additional preparation which made them feel more confident and relaxed.

- enabled them to gain insight based on their bosses' experience and to obtain new things to consider. The ability to obtain the bosses' feedback was also rated very highly.

Weaknesses

- the boss did not have the same information as the seller and, therefore, was unable to truly represent the seller's position and to provide rationale for the cost data. The boss can't anticipate all of the arguments of the real seller and prepare you for what will really happen.

- it lacked realism and was somewhat contrived and artificial. Players could make-up information as they went along to suit their purposes without consequence. The boss did not have a stake in the outcome.

- the scenario had too little information to make it truly meaningful. There was a general lack of information and relevance of information.

- the simulation is not a perfect tool because the boss has basically the same information as the buyer going into the negotiations. Therefore, the boss already knows the buyer's position and bottom line. This knowledge gives the boss an unfair advantage. There is no mechanism to establish a legitimate alternate viewpoint.

- it was a time consuming process that interfered with actual work.

- the simulation will not be effective unless the person playing the seller is motivated to go through the process.

- common assumptions made by the buyer and the boss might affect the expectations of the buyer in the actual negotiation and potentially "cloud" the buyer's judgment. In other words, erroneous assumptions made during the simulation could negatively predispose the negotiator prior to the actual negotiation.

- simulation was difficult to take seriously because the buyer knew that the boss was not the seller and therefore did not have the same

information.

• all the simulation and preparation in the world will not help if the seller is not willing to negotiate.

• knowing my boss was judging my performance during the simulation and that my next raise was on the line made me uneasy in attempting to perform well.

A final question during the post-negotiation questionnaire asked: Regardless of the price you negotiated in the actual negotiation, do you feel that you did a better job of negotiating because you had done the simulation? This question was designed to measure the respondents' belief that they were able to negotiate more effectively during the actual negotiation, specifically asking if it was the simulation which led to this improved performance. Table V presents the results of this question. The overwhelming response to this question was an affirmation that the simulation did improve their preparedness in the actual negotiation.

CONCLUSIONS/RECOMMENDATIONS

In general, simulated negotiations employed by the buyer improves negotiation effectiveness as measured by price. The results of this research indicate that simulated negotiations as a preparation for actual negotiations proved to be beneficial to the outcome. Although the research focuses on the buyer's perspective, simulated negotiations should reap similar benefits for negotiators representing sellers.

Some of the participants noted that the simulated negotiation process did have weaknesses. These results suggest that the success or the effectiveness of the simulated negotiation process is tied directly to the motivation and attitudes of the participants. If the participants view the process as a positive and enriching experience that will better prepare them for contract negotiations, then chances are good that the simulated negotiation process will improve their performance. If, on the other hand, the participants view the process as just another requirement to be fulfilled before the actual negotiation, then there is strong evidence to suggest that the process will be of little value and may in fact be dysfunctional.

A majority of the participants felt that the simulated negotiation helped improve their overall performance in the actual negotiation. Over 95% of the participants agreed that the simulation had indeed helped them to negotiate more effectively in the actual negotiation. This overwhelming majority lends credibility to the simulated negotiation process as an effective preparatory technique for contract negotiations. Furthermore, the results from the questionnaires indicate that a majority of the participants agreed that simulated negotiations were of value and helped them:

- evaluate their negotiation strategy and tactics
- clarify and emphasize the relevant facts
- focus on the real issues
- articulate and solidify their arguments
- identify new issues not previously considered
- improve their line of inquiry
- anticipate questions
- identify the seller's position
- try new strategies, tactics and ideas with little risk

In addition, a strong majority of the participants indicated that they would like to conduct more simulations in preparation for future contract negotiations. Beyond these positive statements concerning the value of simulated negotiations, a majority of the participants indicated that they felt MORE on the following adjectival qualities: confident, relaxed, focused, prepared, motivated, creative, and knowledgeable. In addition, a majority of the participants also indicated that they felt LESS frustrated. A majority of the participants felt the simulation was a worthwhile exercise and was a very valuable preparatory technique.

The simulated negotiation process should be incorporated into the professional training of Government and industry contracting personnel and should be integrated more into graduate and undergraduate level courses that deal with the contract negotiation process. For the students, especially, the simulated negotiation served as an

additional training ground and helped make them feel more prepared and confident concerning their positions. This improved confidence can translate into improved performance in the actual negotiation. Therefore, this kind of preparation in the curriculum of these contracting students could have a significant impact on the future development and professionalism of tomorrow's contracting personnel by providing them greater insight into the negotiation process.

The point is clear that the simulated negotiation process has the potential to save organizations millions of dollars on their contracts. Furthermore, the simulated negotiation process is not just limited to the price of the contract. The improvements achieved through the process could just as well extend to the other terms and conditions. Finally, the simulated negotiation has the additional benefit of conveying to upper management the buying team's objectives and tactics.

The simulated negotiation process should be constructed in order to minimize the amount of required resources and at the same time maximize the effectiveness of the process. It is important to recognize and to drive the point home that the simulated negotiation process is not without associated costs and drawbacks. Engaging in a simulated negotiation is a time consuming process. Therefore, there exists a tradeoff between the amount of time and the costs associated with performing a simulation and the amount of benefits that will be derived from the process in the form of improved negotiated outcomes. And again, it must be emphasized that the simulated negotiation process is no guarantee that an individual or a team of negotiators will achieve their desired outcomes. The process appears to be a function of an individual's motivation and attitude towards the process and therefore, it must be used judiciously and with discretion. Given the costs and drawbacks of doing a simulated negotiation, it is appropriate that it be used in those situations where it appears warranted (contracts with a high dollar value, major or important contracts that will have long term ramifications for the organization, and complicated contracts with difficult issues that involve tradeoffs) and with people who are sufficiently motivated and inclined to make the process work.

BIBLIOGRAPHY

[1] Report of the Commission on Government Procurement, Washington, D.C., 1972.

[2] U.S. Merit Systems Protection Board, Workforce Quality and Federal Procurement: An Assessment, Report to the President and Congress, July 1992.

[3] Morrison, William F., The Pre-Negotiation Planning Book, New York, John Wiley & Sons, Inc., 1985.

[4] Yoder, Dale, Personnel Management and Industrial relations, Englewood Cliffs, Prentice-Hall, Inc. 1970.

[5] Dobler, Donald W., David N. Burt and Lamar Lee, Jr., Purchasing and Materials Management, Fifth Ed., McGraw-Hill Publishing Co., New York, 1990.

[6] Brosius, R. C. and S. R. Erickson, "A Study of the Effect of Simulated Negotiations on Final Negotiated Results," Master's Thesis, Air Force Institute of Technology, Wright-Patterson, Air Force Base, Dayton, Ohio, 1974.

[7] Burt, David N., "Simulated Negotiations: An Experiment," Journal of Purchasing and Materials Management, Spring, 1982, pp. 6-8.

[8] Burt, David N., "A Role-Playing Case for Developing Negotiating Skills," Journal of Purchasing and Materials Management, Winter 1976, pp. 26-30.

TABLE I

SUMMARY DATA OF PRICES NEGOTIATED

GROUP	CONTROL Mean (Std Dev'n) n= pop size	SIMULATION PRICE Mean (Std Dev'n) n= pop size	ACTUAL PRICE Mean (Std Dev'n) n= pop size
TOTAL	2,296,9451.80 (119,091.57) n=31	2,313,319.30 (165,872.41) n=46	2,239,458.70 (150,675.50) n=43
STUDENT	2,306,791.10 (132,750.68) n=23	2,278,500.00 (147,810.10) n=23	2,195,800.00 (99,463.73) n=21
GOVERNMENT	2,226,750.00 (45,350.72) n=4	2,413,168.30 (177,7070.87) n=13	2,313,731.00 (201,233.50) n=12
INDUSTRY	2,310,500.00 (29,338.54) n=4	2,263,600.00 (130,527.54) n=10	2,242,015.00 (132,759.65) n=10

TABLE II

COMPARISON OF ACTUAL PRICES NEGOTIATED

GROUP	COMPARISON TO SIMULATION	COMPARISON TO CONTROL
TOTAL	$73,860.60 less 3.2% decrease	$57,483.10 less 2.5% decrease
STUDENT	$82,700.00 less 3.6% decrease	$110,991.10 less 4.8% decrease
GOVERNMENT	$99,437.30 less 4.1% decrease	$86,981.00 more 3.9% increase
INDUSTRY	$21,585.00 less 1.0% decrease	$68,485.00 less 3.0% decrease

TABLE III

SUMMARY OF LIKERT SCALE QUESTIONS

SIMULATED NEGOTIATIONS:	TOT	STU	GOV	IND
1. Helped evaluate negotiation strategy.	4.30	4.44	3.79	4.63
2. Helped evaluate negotiation tactics.	4.29	4.44	4.07	4.18
3. Helped focus on the real issues.	4.25	4.26	4.07	4.45
4. Helped solidify arguments.	4.39	4.40	4.29	4.45
5. Helped identify new issues.	4.12	4.19	4.00	4.09
6. Helped improve line of inquiry.	4.23	4.33	3.86	4.45
7. Caused change in strategy and tactics.	3.54	3.48	3.71	3.45
8. Caused change in Min, Max and Objective targets.	3.44	3.59	2.86	3.82
9. Were valuable as a preparatory technique.	4.46	4.63	4.21	4.36
10. Increased comfort level with strategy and tactics.	4.48	4.44	4.43	4.64
11. Helped anticipate questions.	4.10	4.26	3.79	4.09
12. Helped identify seller's position.	3.71	3.70	3.43	4.09
13. Helped improve overall performance.	4.35	4.44	4.29	4.18
14. Have encouraged me to use again.	4.39	4.52	3.93	4.64

TOT = Total
STU = Students
GOV = Government
IND = Industry

TABLE IV

SUMMARY OF ADJECTIVAL QUALITIES

	TOTAL	STUDENT	GOVERNMENT	INDUSTRY
Confident	MORE	MORE	MORE	MORE
Anxious	EQUALLY	EQUALLY	LESS	LESS
Bored	EQUALLY	LESS	LESS	EQUALLY
Relaxed	MORE	MORE	MORE	MORE
Time Pressured	EQUALLY	LESS	EQUALLY	LESS
Focused	MORE	MORE	MORE	MORE
Prepared	MORE	MORE	MORE	MORE
Resentful	LESS	EQUALLY	LESS	LESS
Motivated	MORE	MORE	MORE	MORE
Creative	MORE	MORE	MORE	MORE
Knowledgeable	MORE	MORE	MORE	MORE
Frustrated	LESS	LESS	LESS	LESS

TABLE V

SIMULATED NEGOTIATIONS LED TO BETTER ACTUAL NEGOTIATIONS

	TOTAL	STUDENT	GOVERNMENT	INDUSTRY
YES	96%	96%	93%	100%
NO	4%	4%	7%	0

Acquisition for Experimental or Test Purposes (AETP)

Patricia Lemmer and LtCol Les Katahara, United States Air Force

ABSTRACT

Ever had an idea for a product you encountered in the commercial markets but been frustrated at the acquisition red tape that seems to preclude (or greatly delay) actual use by our forces, even for a limited test? Ever needed some test data on commercially available technologies to help support a program decision, but were unable to delay for a "full-up" competition? These are but two scenarios that might radically change if the acquisition team utilizes EXISTING statutory authority at 10 U.S.C. 2274 or 10 U.S.C. 9504 which covers Acquisition for Experimental or Test Purposes (AETP). These statutes authorize acquisition (or lease) of aircraft, aircraft parts, aeronautical accessories, ordnance, signal, and chemical warfare supplies and designs thereof, with or without competition.

Currently, the AETP statutes are not widely used (having been largely limited to Foreign Weapons Evaluation Program (FWEP) buys). AETP authority could streamline the acquisition of necessary hardware and supplies for the test and evaluation portion of the Integrated Weapon System Management (IWSM) spectrum. The Aeronautical Systems Center (ASC) has issued a local AETP policy based on the statutes at 10 U.S.C. 2274 and 9504.

The AETP statutes offer promise of more efficient utilization of dwindling government and contractor manpower, can save taxpayers money, allow quicker technology insertion, and greater flexibility to initiate test programs for commercially available products/technology because competition is not required for the initial experiment or test.

The use of AETP statutes at ASC in FY 93/94 will be closely monitored. Quantitative measures of the actual savings in lead-time and resources should demonstrate the value of judicious utilization of AETP throughout DOD.

INTRODUCTION TO AETP

Background. Have you ever had an idea of how the Department of Defense (DOD) could use a commercial product, but given up in frustration due to mountains of "red tape" that seem to preclude or delay actual use of the commercial product for even a limited test period? Have you ever needed some test data from commercially available technologies to help support a program decision but were unable to wait for a "full-up" competition? Have you ever seen an opportunity to make significant improvements to internal office practices by utilizing rapidly advancing office automation commercial technologies, but wanted to test the interface with other current computer/communication systems to see if the payoff was really there? These scenarios might radically change if the acquisition team utilizes existing statutory authority at 10 U.S.C. 2274 or 9504. (See Figure 1)

The statutes known as **Acquisition for Experimental or Test Purposes (AETP),** provide an invaluable strategy to allow simplified acquisition for test or experiment. We have all experienced Defense Management Review changes, acquisition reform, manpower and budget reductions - it seems these and other initiatives have complicated our acquisition business. This is no news to most of us. AETP can simplify the acquisition of items needed for experiment or test. Metrics and measurement of our processes using lead-time measures seem to point an accusative finger, as if to say, "It takes too long to do the simple and what makes common sense." At ASC, our 180,000 FY 92 contractual actions range from funding actions averaging lead-times of 11 days, to major source selections in 501 days, to definitive contracts under $5M in 57 days. But, contracting lead-time is only one part of the story. Consider the true lead-time to deploy a specific technology to the field and we see it can take years or decades! AETP can shorten both lead-times and use less resources doing it.

The Aeronautical Systems Center (ASC) at Wright-Patterson AFB, OH has issued a local AETP policy based on the statutes at 10 U.S.C. 2274 and 9504. The AETP statutes authorize acquisition (or lease) of aircraft; aircraft parts; aeronautical accessories; ordnance, signal, and chemical warfare supplies; (and designs thereof) for experimental or test purposes, with or without competition! Interested? Read on!

Any new acquisition strategy must 1) improve the Air Force mission and 2) satisfy the overall intent of the Competition in Contracting Act (CICA) statute - that is to promote competition in the most MEANINGFUL way. So, the AETP story can best be understood by looking at the legislative history and historical application of the AETP statutes.

Legislative History. Section 2274 of Title 10, United States Code, *Procurement for experimental purposes,* provides in pertinent part:

> (a) The Secretary of a military department may buy designs, aircraft, aircraft parts and aeronautical accessories that he considers necessary for experimental purposes in the development of the best kinds of those items for the Army, Navy, Air Force, or Marine Corps, as the case may be. Purchases may be made abroad or in the United States or the Territories, commonwealths, and possessions, with or without competition and by contract or otherwise.

Section 9504, *Procurement for experimental purposes* provides in pertinent part:

> The Secretary of the Air Force may buy ordnance, signal, and chemical warfare supplies, including parts and accessories, and designs thereof, that he considers necessary for experimental or test purposes in the development of the best supplies that are needed for the national defense. Purchases under this section may be made inside or outside the United States, with or without competitive bidding, and by contract or otherwise.

The former statute originated in legislation originally passed as part of the Air Corps Act of July 2, 1926. The bill apparently was originally conceived over concern that United States air power lacked superiority in the post World War I era. The proposed bill was an attempt to address the air superiority issue by providing more flexibility to procure aeronautical items for experimental purposes at home or abroad. Production, however, was to be done by domestic enterprises only. This legislation has since been codified at 10 United States Code § 2274.

In 1930 the War Department became concerned over the time and cost required to develop equipment and supplies for the national defense. As a result a bill expressly designed to extend the provisions of the original legislation was enacted to cover purchases of signal, ordnance, and chemical warfare items for experimental or test purposes. This legislation is now codified at 10 United States Code § 9504.

The Competition in Contracting Act (CICA) was passed in 1984, requiring full and open competition unless an acquisition falls under certain enumerated exceptions.[1] Thus, on its face, CICA may appear to directly contradict the above statutes. Nonetheless, the rules of statutory construction disfavor implicit repeal of earlier laws. Clear evidence of Congress' intent to implicitly repeal earlier statutes is required to support such a position. Such evidence is absent in the instant case. In fact, CICA explicitly provides for exemptions from full and open competition when "expressly authorized by statute." It is, therefore, clear that these statutes survive the Competition in Contracting Act and are currently available to support such procurement without competition.

AETP

Thesis. This paper will communicate 1) the existence of AETP statutes to the DOD acquisition community and 2) the sensible implementation policy developed at ASC. It will defend the following thesis: **AETP statutes at 10 U.S.C. 2274 and 9504 offer more efficient utilization of dwindling government and contractor resources, can save taxpayers money, allow quicker technology insertion, and greater flexibility to conduct test programs for commercially available products or technology, and are likely to generate more meaningful competition in the future as technologies and products are proven to be useful for DOD.**

Lastly, a warning to those who hope AETP will solve all of your problems. AETP is not a panacea - **it is not appropriate to acquire production quantities or for acquisitions outside the experiment or test phase.**

Genesis of AETP Policy. The opening chapter of the AETP story at ASC was written by a process review team which met in June 1990 to improve and streamline the PRAM/RAMTIP contracting process. These

two ASC offices are chartered to insert existing and emerging technologies into Air Force aircraft, missiles, and support equipment. The Productivity, Reliability, Availability, and Maintainability (PRAM) Program Office inserts mature, off-the-shelf technology into existing weapon systems, support equipment, and maintenance depot operations. The Reliability and Maintainability Technology Insertion Program (RAMTIP) Office focuses on emerging technologies that can be applied to current systems and those under development. In 1990, PRAM and RAMTIP recognized a need to reduce the time it takes to insert technologies: PRAM programs took 36 months to go from an idea to a fielded system, and more complex RAMTIP programs took 48 months![2] This need to reduce PRAM/RAMTIP lead-times indirectly resulted in the AETP policy. The outcome of the PRAM process review team effort was six specific recommendations, one of which was to develop a new CICA exception to Full and Open Competition in the DFARS Part 206.302-1 to allow the test and evaluation of domestic systems and equipment (similar to the exception that exists for the Foreign Comparative Testing Program).[3]

Chapter two of AETP opens with the preparations in Nov 90 to develop a FAR case for the new CICA exception for testing of domestic items. The first step was to check the data that the process review team had generated. Among the documentation was a note with the two statutory references and some old Secretary of the Air Force (SAF) and Air Force Systems Command (AFSC) staffing documents discussing these same statutes. Next, a trip to the law library to read the cited statutes. They were amazingly short and concise. At that point, the realization that ASC did not need to develop a FAR case to allow us to process J&As under CICA - **we already had statutory authority to acquire items required for experiment or test (both foreign and domestic)!** The "contracting types" readily agreed that the two statutes appeared to provide the basis for a "new" acquisition authority and that we ought to research it and then issue a local policy. Next, it was necessary to tell the AETP story to the attorneys and see if they found our conclusion defensible.

Chapter three started with a request for a legal opinion of the AETP statutes, their legislative history, and any potential conflict with the CICA statute. In Sept 1991, the ASC/JAG legal opinion was received. It stated in part, "There is in our opinion, no direct conflict between 10 U.S.C. 2274, 10 U.S.C. 9504, and CICA."[4] The legal opinion also stated that delegation of authority from the Secretary had taken place.[5] It was decided that the package outlining the local policy would be sent to legal and contracting at HQ AFSC for their review. The ASC policy was refined and coordinated internally with contracting, legal, and PRAM personnel. In early 1992, it was decided to issue the local policy and then notify the new HQ Air Force Materiel Command (AFMC) after the merger of the old Logistics and Systems Commands was complete.[6] Internal ASC coordination was completed on 13 Nov 92 and PK policy letter 92-054 was issued to the ASC contracting workforce.[7]

ASC Policy and Procedures. The ASC policy letter provides guidance on the background of the AETP statutes and examples of proper usage or application. It emphasizes that work for research and/or development of equipment, designs, etc. or work other than experimental or test purposes is not allowable using AETP. Several scenarios are briefly described which we believe are permissible under AETP authority: test quantities of items; some testing services (limited); and minor

modifications to equipment for test purposes, etc. Until substantial experience is gained at ASC, use of AETP authority will require a Determination and Findings (D&F) executed by the Program Manager, Contracting Officer, Staff Judge Advocate, and the Competition Advocate (only if over $5M). (See Figure 2) Our local procedures guarantee a legal review and coordination on **every** application of the AETP authority; Competition Advocate staff review on significant (over $2M) actions with Competition Advocate approval when over $5M; and an annual report to ASC/PKC of all acquisitions where AETP authority has been used. In addition to the policy letter, the ASC FAR Supplement part 17 was modified to clearly detail AETP authority, applications, and procedures.[8]

It is hoped that valid measurements can be developed to assess savings in lead-time and resources to demonstrate the value of judicious utilization of AETP throughout DOD. Realistically, it will take the remainder of FY 93 and FY 94 to gain significant experience utilizing AETP at ASC.

Potential ASC Applications. AETP applications are likely to be small one time buys or lease, and are restricted to limited quantities of items or supplies needed for experimental or test purposes. Disposable items may require thousands of items for testing over a defined time period, whereas, larger, complex items may be purchased or leased in quantities of only one.

Examples of situations where AETP authority is appropriate include: limited quantities of equipment or supplies needed for governmental testing of commercial items in the field (as in the PRAM/RAMTIP mission); Prime Mission Equipment (PME) or existing military hardware required by test programs directed by PMDs or other established requirements; items, parts, or equipment required for item qualification testing as required in FAR part 9.2; demonstrations of compatibility of computer-communications equipment with pre-existent AF computer-communications systems; non-developmental item advocacy; minor modifications to commercially available items for test purposes, safety issues, fit, or test data collection; or design studies that result in a specific design/methodology to be used in test and experimentation. Testing services may be covered only in limited situations as ASC has interpreted that AETP authority is not intended to cover general testing services.

Based on review of recent J&A files where a CICA exception to Full and Open Competition was obtained, it appears that ASC may process approximately 30 AETP acquisitions annually. This number might be larger if small source selections are eliminated in favor of AETP authority. It also depends on the impact of several organizations now included in ASC as a result of the addition of the old Wright-Patterson Contracting Center. It is difficult to estimate with much certainty the number of ASC uses of AETP.

Non-ASC Applications. ASC is the only AF organization known to be using AETP and a quick check with Army & Navy Competition Advocates didn't indicate that they utilize the AETP statutes.

Technology Transfer. Although the AETP statutes are not to be used for true R&D, it is conceivable that they will be useful for technology transfer from both the commercial sector AND government laboratories into DOD systems. Limited duration testing of these technologies can be accomplished quickly and provide feasibility data to our Program Managers. As defense laboratories work to reorient their research focus to

commercial applications of technological breakthroughs, smarter and quicker acquisition strategies will be important.[10] That is the real payoff of AETP. After the AETP testing, any production quantities will be required to comply with the CICA requirement for competition.

Lease. The lease aspects of AETP are based on the fact that the original statutes use the terms "procurement" and "buy" which aren't defined in the FAR. We have equated "procurement" with the current term of acquisition to include both purchase and lease.[9] Also, we look at lease as a temporary purchase that makes the most sense for high dollar equipment for a limited experiment or test period.

Issues Remaining. The final chapters of the AETP story have yet to be written. Other organizations will now have a hand in determining how the AETP story ends. Also, several challenges remain to be worked at ASC. To fully utilize these statutes we need to "Get the word out." The policy letter has been issued in the contracting community but there remains some **training** to increase awareness within the acquisition community. Development of **specific metrics** to assess the lead-time reductions and savings in resources has yet to be done. Common sense tells us that these are real benefits but we would like to quantify them. **Color of money** (i.e. R&D Vs. production money) should not be an issue since we believe it is appropriate to use R&D funds for AETP testing.

CONCLUSION

The AETP statutes at 10 U.S.C. 2274 and 9504 hold great promise of savings in resources, shorter lead-times, and quicker technology insertion because experimental or test efforts may be contracted for quickly and directly. Competition is enhanced in the long-term because managers will be able to obtain test data needed for decision making on requirements for subsequent development or production. The use of AETP statutes at ASC by SPOs, Operational & Specialized Contracting, Wright and Armament Laboratories, and for PRAM/RAMTIP projects in FY 93/94 will be monitored. Quantitative measures of the actual savings in lead-time and resources should demonstrate the value of judicious utilization of AETP throughout DOD.

Additional information concerning the AETP statutes and the ASC policy implementing them may be obtained from Patricia Lemmer, ASC/PKCA Bldg. 14, 1865 Fourth St Ste 8, Wright-Patterson AFB OH 45433-7122, telephone (513)255-4192 or DSN 785-4192. Lt Col Lester Katahara can be reached at AFCLC/JANA Bldg 11, 2240 B St Ste 8, Wright-Patterson AFB OH 45433-7122, telephone (513)255-5270,x221.

The authors would like to thank the contracting officers who helped to shape this AETP policy, the process review team and PRAM who first identified the need, and the others who offered suggestions and encouraged us! This paper reflects the views of the authors and does not reflect the opinions of ASC as a whole.

2274. Procurement for experimental purposes

(a) The Secretary of a military department may buy designs, aircraft, aircraft parts, and aeronautical accessories that he considers necessary for experimental purposes in the development of the best kinds of those items for the Army, Navy, Air Force, or Marine Corps, as .the case may be. Purchases under this subsection may be made abroad or in the United States or the Territories, Commonwealths, and possessions, with or without competition and by contract or otherwise.

(b) If, as a result of a purchase under subsection (a), a new or suitable design considered to be the best kind for the Army, Navy, Air Forcc. or Marine Corps, as the case may be, is developed, the Secretary of the military department concerned may contract for procurement of the item in quantity. Contracts under this subsection are subject to sections 2272(f) and 2279 of this title but are not subject to sections 2271(a) (d) and 2272(a) of this title.

(Aug. lO, 1956, C. 1041, 70A Stat. 126.)

9504. Procurement for experimental purposes

The Secretary of the Air Force may buy ordnance, signal, and chemical warfare supplies, including parts and accessories, and designs thereof, that he considers necessary for experimental or test purposes in the development of the best supplies that are needed for the national defense. Purchases under this section may be made inside or outside the United States, with or without competitive bidding, and by contract or otherwise. Chapter 137 of this title applies when such purchases are made in quantity. Aug. 10, 1956, c. 1041. 70A Stat. 575.

AETP Statutes from 10 U.S.C.

Figure 1

DEPARTMENT OF THE AIR FORCE
DETERMINATION AND FINDINGS

Authorization to Enter into a Contract Under the
Acquisition for Experimentation and Test Purposes Statutes

Upon the basis of the following findings and determination, the proposed contract/lease for ________ (item name and quantity) _______may be entered into pursuant to the authority of 10 U.S.C. 2274 and /or 9504.

FINDINGS

1. Statement of Need:
____________ (Description of technical attributes of item(s) ___ ______
_____________ that will be tested for military applications.) ___________

2. Technical Determination of Optimal Technology/Item:
_______ (Selection of name brands, P/N, or process to be tested.)______
____

3. Method of Test/Experimentation Description and Quantity to be Tested:
____
____
____

DETERMINATION

The proposed contract/lease for ___ (dollar value) __ may be entered into pursuant to the AETP statute(s).

I certify the above to be true.

__Requirements Office signature__ __Legal Coordination__

__Contracting Officer signature__ __Competition Advocate (over $5M)__

ASC FAR SUPPLEMENT Figure 5317.96-2 -- AETP Determination and Findings

Figure 2

AETP Bibliography

1. See 10 U.S.C. 2304 and 41 U.S.C. 253 and Federal Acquisition Regulation Part 6.

2. Leading Edge, November 1992, "Technology Insertion Picks Up The Pace", pg. 6.

3. See Defense Federal Acquisition Regulation Supplement 206.302-1(b) which provides authority for the DOD Foreign Comparative Testing Program. NOTE: Previously DFARS 206.302-1(b)(S-70) under DAC #88-14 covered the Foreign Weapons Evaluation Program.

4. AFCLC/JANA Opinion 91-365 dated Sept 25, 1991, "Acquisition of Articles for Experimental or Test Purposes Without Competition".

5. See Air Force Federal Acquisition Regulation Supplement (FARS) 5301.601-92 and Secretary of the Air Force Order (SAFO) 650.4.

6. On 1 July 1992 the Air Force Logistics Command (AFLC) and Air Force Systems Command (AFSC) merged to become the Air Force Materiel Command (AFMC).

7. ASC/PK Policy letter 92-054, Acquisition for Experimental or Test Purposes (AETP) Without Competition, 10 U.S.C. 2274 and 9504, dated 13 Nov 92.

8. See Aeronautical Systems Center FARS 5317.96, "Acquisition for Experimental or Test Purposes (AETP).

9. See definition of acquisition at the Federal Acquisition Regulation (FAR) 2.101.

10. Aviation Week and Space Technology, Dec. 7, 1992, "US Labs Reorient to New Endeavors", pg. 46.

The Concept of Value in Government Contracting

by Robert E. Lloyd
U.S. Department of State*

ABSTRACT

The Defense Management Review (DMR) has been a major force for change in Defense acquisition in recent years. One of its fundamental principles is that contracting rules should be limited to only those procedures and practices which "add value." Regrettably, there has been no formal definition of the term "value" to guide the intended changes in the acquisition system, even though this term has long been the source of a lively debate as to its meaning. This paper reviews the varied definitions of value in an effort to reach an understanding of the concept that will provide a standard by which to judge the results of the DMR.

The concept of value appears in a variety of different contexts in Government contracting, including "best value" acquisition and value engineering. Value has also been studied extensively in other fields such as philosophy and economics, where writers have regarded the principle of value in ways as varied as subjective preferences (as in axiology), a measure of utility (as in Austrian economics), or even as a function solely of labor applied (as in the Marxist labor theory of value).

After an analysis of this array of definitions, an attempt is made to provide a baseline for judging future acquisition policy and its implementation. The paper concludes that value is a weak criterion by which to judge acquisition policy, and unless a consistent view of value is adopted, the DMR implementation in the future may allow purely subjective uses of this concept to perpetuate the same deficient management practices that originally prompted the DMR.

*The views and opinions expressed are solely the author's and do not necessarily represent those of the U.S. Government.

INTRODUCTION

The "Joint OSD-DOD Component Regulatory Relief Task Force" formed pursuant to the DMR conducted a complete review of all Department of Defense (DOD) acquisition-related guidance with an eye toward streamlining such policies and procedures and focusing on practical use. The task force report concluded with its own guidance that "the need for a policy, procedure, or requirement must clearly provide value added to our fundamental mission."[1] DOD's fundamental mission is to provide the military forces needed to deter war and protect the security of our country.[2] The problem is that, while this mission may be clear, the Task Force did not define the meaning of "value". This is not surprising. A uniform, satisfactory definition of the term has never been developed. For example, Hall's 250 page book titled What is Value? concluded that an answer cannot be formulated.[3] Smart notes that "the history of economic science is strewn with wrecks of theories of value."[4] By reviewing these value theories we will be able to discern whether the use of "value added" as a criterion for acquisition policy provides a sound basis to guide policy makers.

LAW AND REGULATION

The Federal Acquisition Regulation (FAR) contains three explicit references to "value":

- FAR 15.605(c) regarding best value contracts;
- FAR 15.812(c) concerning the value added by noncompetitive supply contractors; and
- FAR Part 48 on value engineering (VE).

In each case, the FAR envisions a different concept of value, although in no case is the term explicitly defined.

The first reference states that, in certain acquisitions, the Government may select the source whose proposal offers the greatest value to the Government in terms of performance and other factors. Several authors have attempted to define this as "best value," meaning acquisitions where price factors are not the primary determinant of who receives the contract award. Best value decisions include technical, performance, and price considerations.[5] Greatest value has also been defined simply as a type of award decision in which technical factors are considered more important than price.[6] While such definitions are relatively straightforward and unambiguous, they provide little help for the acquisition manager in determining whether to issue a policy or procedure. Certainly both cost and technical factors must be considered, but beyond that there is no clear standard in this portion of the FAR for deciding when an acquisition policy "adds value."

The second citation is based on the only statutory reference to value in procurement law (10 U.S.C. 2304(i)(2)(B)), which requires that, in the case of a noncompetitive supply contract, the contractor must identify those supplies it did not manufacture or to which it did not contribute "significant value." This rule is presumably for the purpose of enabling the Government to negotiate better prices by seeking to reduce the indirect costs or profit associated with subcontracted items. Again, value is not defined, but it appears to mean labor or similar production effort when dealing with so-called value-added resellers (VARs). As will be discussed below, somehow it seems incongruous for DOD to be relying on the equivalent of a labor theory of value in its contract relations with capitalist industry.

The third area listed above, VE, features relatively lengthy coverage in the FAR compared to the other two citations, but still no definition of value is provided. Nevertheless, the literature on value engineering provides ample discussion of the matter, and a consensus appears to have been reached on a definition which resembles that used for greatest value acquisition; VE writers consistently describe value as a relationship between function or performance and cost.

The founder of VE, Larry Miles, defines value as appropriate performance and cost. Value can be increased by decreasing costs or increasing performance.[7] Jerry Kaufman provides the clearest definition of value: function divided by cost. He notes that value as viewed by the producer is the ratio of function to cost, but as viewed by the buyer means perceived benefits divided by price. This seemingly clear definition masks a larger complexity. To gauge value by comparing benefits to price is essentially to engage in traditional cost-benefit analysis, which has long been criticized for its weaknesses in a normative sense as well as its inadequacy in treating intangible factors.[8] To assess value in terms of function is likewise difficult to do objectively; Kaufman defines function as the intent or purpose of a product or system, operating in its normally prescribed manner, i.e., anything that makes an item or system work or sell. He insists, however, that function <u>cannot</u> be quantitatively expressed.[9]

At least one other VE author has elaborated on this last point. Fallon's VE text, quoting Frondizi, asks whether values have to be necessarily objective or subjective; he views absolute definitions as missing the point, for value is inherently both objective and subjective.[10] Our search for a definition of value which can readily serve as a benchmark for acquisition policy makers must therefore go beyond the boundaries of VE and the FAR.

AXIOLOGY AND SUBJECTIVE DEFINITIONS

One of the chief problems with the term "value" is that unfortunately, as Rescher notes, "in the English language the word is used in a somewhat loose and fluctuating way."[11] Value has been variously described as personal bias, attribution, empirical quality, logically indefinable, self-realization, a qualified object of interest, and so on.[12] Mudge's study of value[13] notes that "Value is a

difficult word to define because it is applied to both subjective qualities (those determined by the emotions) and objective qualities (those determined by external characteristics)." Of all the standards to choose for judging acquisition policy, value is surely one of the least impressive. The established field of philosophical study known as axiology, which deals with the general theory of value, has sought a unified philosophy of value but is generally regarded as unsuccessful.[14]

Axiology has been dominated by a dichotomy between objective and subjective value. For example, Aristotle named seven classes of value: economic, moral, aesthetic, social, political, religious, and judicial, of which only the economic was considered objective and measurable in external units. Yet even within economic value can be found both subjective and objective qualities: use value (properties that accomplish a use, work, or service; esteem value (properties that make ownership of an object desirable); cost value (properties which are the sum of the labor, material, overhead, and other costs to produce something); and exchange value (properties of an object that make it possible to procure other things by trading). A single outlook on value can be misleading.[15]

Rescher claims that a value is no more than a slogan capable of providing rationalization for action by reflecting a positive attitude toward a supposedly beneficial state of affairs.[16] This makes value little more than personal preference masquerading as objective criterion. An adequate theory of value should account for both aspects of value: some things are valued because they are regarded by people in a certain way, and other things because they are valuable, i.e., objectively possessed of certain value-endowing features. To exclude subjectivity from value is impossible. Value must be assessed not abstractly but in context.

Edel's survey of value theory[17] also asserts that there is no unity of definition when discussing value. In this century, the generic concept of value was so vague that it could encompass preferential tendencies of people in any field, because the term had just enough ambiguity to connote both a state of liking and criteria for evaluation. American social scientists focused on value studies, but the concept of value was not clarified; value was often used as a judgmental reference, as the criteria employed for evaluation of conduct/decision or for justifying norms. By Pareto's time, efforts to compare values across individuals had been abandoned, and valuation was considered the expression of preferences aimed at overall maximization. Value thus characterized any interest that motivates a person. Although Dewey refined the definition of value as selection and rejection rather than simply desire, in an effort to form a more neutral term (less reminiscent of hedonism), the subjectivity inherent in the word remains inescapable.

Perhaps the most prominent recent philosophical work on value theory, David Gauthier's Morals by Agreement, comes down squarely on the side of treating value as a subjective, relativistic measure of individual preference. "Value is not an inherent characteristic of things or states of affairs...independent of persons and their activities." Gauthier argues that the best explanation for human action is that "choice maximizes preference fulfillment given belief." Values are not objective in this theory, but instead value is "subjective because it is a measure of preference and relative because it is a measure of individual preference."[18]

The results of axiology have, like the regulatory uses of value, failed to produce a consistent, meaningful standard of value on which to judge acquisition policy. To base policy on personal preferences (as much value theory amounts to) is to continue regulating contracts as we have in the past, without any change in substance. Before concluding that subjective analysis is unavoidable, however, we should consider the chances for discovering useful criteria in another field: economics.

ECONOMICS AND OBJECTIVE DEFINITIONS

Perhaps the greatest effort at defining value has been made by economists. A leading dictionary of economics[19] defines value as the intrinsic worth of a commodity. If defined in terms of money, value determines price. Traditionally there have been separate concepts of use value and value in exchange; value in use is the capacity to satisfy human wants, while value in exchange is the worth of a commodity in terms of its capacity to be exchanged for another commodity. Classical economists required the existence of use value or utility/usefulness for an item to be exchanged; exchange value was considered to be determined by the cost of production (wages, profit, and rent). Although the so-called "labor theory of value" is best known from the works of Karl Marx, it actually has its origin in Adam Smith's Wealth of Nations. Smith argued that labor is the true measure of the value of commodities, because what something is worth to someone is the "toil and trouble which it can save to himself, and which it can impose upon other people."[20]

Ricardo further advanced the labor theory of value, arguing that the value of a commodity depends on the relative quantity of labor necessary for its production, though this held true only under certain special conditions. In the Ricardian system, the theory of value was a real-cost theory, with labor as most important empirical factor. The labor theory of value, as modified, was deemed the best general explanation of relative prices; the relation between value and labor-time is that every increase in the quantity of labor must augment the value of the commodity on which it is exercised, but the value of some commodities is due to scarcity alone.

In the late nineteenth century, neoclassical economists focused on market price rather than the intrinsic value analyzed in the labor theory of value. They viewed price as determined by marginal utility of a commodity and hence the source of exchange value. Marshall's supply and demand curves were derived from utility; the theory of value became a theory of allocation of scarce resources to specific uses rather than a search for intrinsic value. Modern theory continues this line, with its dual incentives of utility maximization for consumer (demand) and profit maximization for producer (supply), based on the unifying principle of marginal utility.

Only Marxists retained the separation of value theory (labor theory of value or theory of profit/surplus value) from the theory of price determination. Sowell notes that to Marx, value was the units of society's labor, the underlying essence and the relations among commodities, while exchange value is only a surface appearance.[21] To Marx, labor was the essence of all value, and value was an objective property of every commodity. He was not impressed by subjective interpretations of value based on utility, since he was a materialist; the objective common element in all commodities was labor. Market prices were not random but fluctuated around a definite point, the cost of production based on labor, so value was determined not by laws of the market but by production itself.[22]

This line of thinking, while intriguing, has no application to contemporary acquisition policy, for to argue that any application of labor in the development of a contracting procedure adds value is to provide no standard at all and could lead to a nearly infinite increase in regulations. Furthermore, Nozick's trenchant critique of the labor theory of value points out that Marx's central notion of socially necessary labor time is itself defined in terms of the processes and exchange ratios of a competitive market. This analysis reveals the tautology inherent in Marxist value theory.[23]

Perhaps the most ambitious explorations in value theory were made by the so-called Austrian school of economics, principally Eugen von Böhm-Bawerk, who once again distinguished two types of value: subjective and objective. In his value theory, some objects have intrinsic value, while others are considered valuable only as a means to an end: economic value. In its

subjective sense, value denotes the significance which a good possesses for the well-being of a certain subject, meaning that possession of this good satisfies some want, provides some gratification, affords some pleasure, or spares some pain, which one would be forced to forego if one did not possess the good. The presence of a good means a gain for one's well-being. The other kind of value is objective, signifying our estimate of the capacity of a good to bring about some definite extrinsic objective result. This defines value as an appraisal of the relationship that exists between the good and the accomplishment of some objective purpose or result. The phenomenon of value thus has a dual nature.

Böhm-Bawerk's formal definition of value is the significance which a good possesses for promoting the well-being of an individual. All goods have usefulness, but not all goods have value; in order for value to exist, usefulness must be paired with scarcity. Any value that exists at all is *concrete*; there is no abstract categorical value. The value of a good is determined by its marginal utility, and the magnitude of marginal utility depends on the relation between wants and the wherewithal to satisfy them. Usefulness and scarcity are the ultimate determinants of value.[24] In the over-regulated world of Government contracts, a cynic might argue that the best way to increase the value added by today's acquisition policies is to make them as scarce as possible.

Another celebrated Austrian economist, Carl Menger, was even more insistent on the subjective character of value. He argued that if economizing individuals perceive that the satisfaction of one of their needs is dependent upon their command of a good, then this good attains for them the significance we call value. The value of goods springs from the same source as the economic character of goods, i.e., the relationship between requirements for and available quantities of goods. Value is not inherent in goods but merely the importance that we attribute to the satisfaction of our needs. That a good has value to us is attributable to the fact that command of it has for us the significance of satisfying a need that would not be provided for if we did not have command of the good.

The value of goods arises from their relationship to our needs and is not inherent in the goods themselves. It is erroneous, Menger argued, to speak of values as independent real things and to objectify value in this way. Objectification of the value of goods without relation to their importance to economizing individuals is subjective in nature and causes confusion. Only satisfactions have importance for us; value is imputed. The measure of value is entirely <u>subjective</u> in nature, and for this reason a good can have great value to one individual, little value to another, and no value to a third, depending on the differences in their requirements and available amounts.[25]

If marginal utility determines value, though, then value is solely a matter of whose perception, personal preferences, or utility are at stake, which is hardly a meaningful standard for the development of acquisition policy. Returning to the dictionary again, "value-added" is defined as the value of the firm's output minus the value of the inputs it purchases from other firms.[26] In a Government contract context, this means subtracting the prime contractor's subcontract costs from the contract price to the Government to determine if any "value" was added. The regulatory analogy of adopting such a principle would be to require policy makers to estimate the worth of the output and ensure that this exceeded the cost of the inputs (drafting and implementing a regulation), somewhat akin to a cost-benefit analysis (although the DMR Task Force wisely did not impose any such requirement). Consequently, this seemingly objective definition once again conceals a more complex situation.

As mentioned above, the standard methodology for cost-benefit analysis has been subjected to serious question in terms of its legitimacy as a basis for policy. If acquisition policy is intended to maximize the benefit/cost ratio for DOD's mission, this must involve measurement of preferences of both

the individuals performing contracts and those who rely on contracts for implementation of their programs. Such measurement is both practically and technically difficult and can also be skewed by individuals who misrepresent their preferences. For example, different policy drafters may have different goals, reflecting either personal biases or an underlying statutory ambiguity which is subject to varying interpretation by different analysts. Some may seek efficiency while others advocate internal controls or fairness and equity in the treatment of contractors as a guiding principle.

In addition, the measurement process generally falls short in addressing intangible costs and benefits, as well as failing to account for the concerns of equity. The practical problem is best summed up by Paris and Reynolds:

> "How close can the analyst come to making accurate assessment of the costs and benefits of alternative policy proposals? If cost-benefit analysis is to be intellectually sound, it is necessary to assess the full range of costs and benefits associated with each alternative. The sheer number of effects is likely to make this a difficult task. It is compounded by the fact that many effects may be unintended and thus hard to identify, much less evaluate."[27]

Measurement decisions in cost-benefit analysis may clearly reflect subjective or ideological determinations. Further, to include externalities and intangibles in the analysis means that their assessment "may tend to have the status of highly subjective guesses."[28]

This sentiment is echoed in a recent work by Formaini, who uses the learning of Austrian economics to challenge the very notion of scientific cost-benefit analysis by pointing out that, due to the lack of objective data regarding both costs and benefits, no claim can be made for the rationality of a public policy or undertaking. He concludes that all policy is normative in nature.[29] Our hope for objective criteria for value theory in the form of cost-benefit analysis has thus proved fruitless.

CONCLUSION

Even if we are unable to remove all subjective elements from value theory, there may yet be standards which are reasonably objective, recognizing that we will never attain complete objectivity. In the search for a less ambiguous standard, we might look to the statutory goal of efficiency[30] in trying to develop examples of how to make policy which promotes efficiency. Such examples might include reducing lead-time for contracting, eliminating paperwork burdens, or obtaining better prices or performance. It cannot be expected, however, that standards such as these will be available as criteria in most cases where a new acquisition policy is being contemplated. In addition, focusing solely on efficiency will cause the exclusion of policies enacted for reasons such as internal control or fairness to contractors. The relatively objective standard of efficiency is itself problematic, which means we should face up to the relativism and duality inherent in any attempt to use value as a criterion for judging policy. Perhaps it is best to abandon the pretense of objectivity and impartiality and recognize that acquisition policy is as susceptible to abuse as any other aspect of Government contracting reform.

A review of the various definitions and meanings of value points to a definite conclusion: in seeking a basis for evaluating the wisdom of acquisition policy, one would be hard pressed to choose a less helpful standard than value. The concept of value has a long history of difficulty in its definition; in fact, if any consensus has been reached at all in the field of value inquiry, it is that it is impossible to separate the objective and subjective elements of value. Despite the DMR's intention to instill a greater sense of discipline and rationality in Defense acquisition management, the consequence of judging policy by the fuzzy standard of "value added" cannot be to increase the

effectiveness of acquisition policy-making. While efficiency may offer some occasional usefulness as a tool in deciding which acquisition policies and procedures to issue, the concept of using "value added" as a basis for deciding the appropriateness of a policy is a misguided idea.

REFERENCES

1. Federal Contracts Report (January 29, 1990), 151, 170-171.

2. United States Government Manual (Washington: Government Printing Office, 1992/1992), 183.

3. Everett W. Hall, What is Value? (London: Routledge & Kegan Paul, 1952), 247.

4. William Smart, An Introduction to the Theory of Value (New York: Augustus Kelley, 1891), 1.

5. Richard J. Hernandez, Best Value Contracting (NCMA: Topical Issues in *Procurement Series 3:5, May 1992*), 2-3.

6. General Services Administration, ADP Protest Report IV:4 (July 1992), 1.

7. Larry Miles, Techniques of Value Analysis and Value Engineering (Miles Value Foundation, 3d Ed., 1989), 4-5. See also Air Force Pamphlet 320-2, Value Engineering Guide for Contractors (1985), 2; Navy Value Engineering Applications and Contractual Implementations (Analysis and Technology, Inc., North Stonington, CT: 1988, 2-2-1).

8. David C. Paris and James F. Reynolds, The Logic of Policy Inquiry (New York: Longman, 1983), 113-115.

9. J. Jerry Kaufman, Value Engineering for the Practitioner (North Carolina State University Press, 1985), 1-4, 1-5.

10. Carlos Fallon, Value Analysis (Miles Value Foundation, 2d Ed., 1980), 1-33.

11. Nicholas Rescher, Introduction to Value Theory (Prentice-Hall, 1969), 1.

12. Ralph Barton Perry, General Theory of Value (Harvard, 1950).

13. Arthur E. Mudge, Value Engineering: A Systematic Approach (Pittsburgh: J. Pohl Associates, 1989), 12-14.

14. Rescher, supra, 1.

15. Mudge, supra.

16. Rescher, supra, 9.

17. Abraham Edel, The Concept of Value and Its Travels in Twentieth Century America (Philadelphia: Temple University Press, 1988), 14-31.

18. David Gauthier, Morals by Agreement (New York: Oxford University Press, 1986), 47-59.

19. David W. Pearce, ed., MIT Dictionary of Modern Economics (MIT Press, 1986), 439-440.

20. Adam Smith, An Inquiry into the Nature and Causes of the Wealth of Nations (Indianapolis: Liberty Press, 1981), I:V, 47.

21. Thomas Sowell, Marxism (New York: William Morrow, 1985), 106-142.

22. Robert B. Ekelund, Jr. and Robert F. Hebert, A History of Economic Theory and Method (New York: McGraw-Hill, 1990), 106-107, 149-150, 270-273, 324-325.

23. Robert Nozick, Anarchy, State, and Utopia (New York: Basic Books, 1974), 260.

24. Eugen von Böhm-Bawerk, Capital and Interest, Volume II: Positive Theory of Capital (South Holland, IL: Libertarian Press, 1959), 121-201.

25. Carl Menger, Principles of Economics (New York: NYU Press, 1976), 114-233.

26. MIT, supra, 440.

27. Paris and Reynolds, supra, 119.

28. Ibid, 119-124.

29. Robert Formaini, The Myth of Scientific Public Policy (New Brunswick: Transaction Publishers, 1990), 58-65, 96.

30. 10 U.S.C. 2301; 40 U.S.C. 471, 481, 759.

ACQUISITION KNOWLEDGE & INFORMATION LOCATOR SYSTEM

Dr. Andrew P. Mosier and John R. Mathias
MARTS Associates

ABSTRACT

This paper summarizes key concepts developed over seventeen years toward a two-stage capstone concept for increasing productivity substantially in an Integrated-DSM (Defense Systems Management) or IDSM process that covers the life cycle of every defense system. The central first-stage question is: How to provide every Defense Systems Acquisition Management (DSAM) professional better access to the huge, widely distributed, body of DSAM knowledge, whenever the professional needs relevant DSAM knowledge and information (K&I)?

The two-stage capstone is a concept for long-term evolutionary development of a DSAM, then an IDSM K&I Locator System. The system would increasingly enable professionals, first in DSAM, then in IDSM *centers of management excellence* throughout their respective communities to access relevant DSAM/IDSM K&I when needed in a job or for a task at hand.

The concept, when implemented, will increase productivity of professionals, first throughout the DSAM community, then throughout the IDSM community, and thus, increase productivity substantially in a seamlessly integrated IDSM process covering every defense system's entire life cycle.

INTRODUCTION

This paper concerns productivity, and systems concepts for increasing productivity. Implementing these concepts will substantially increase DSM process productivity of two groups of professionals,[1] DSAM professionals, and future IDSM professionals.

The DoD should act now to begin using new Information Management Technologies (IMT)[2] to implement these concepts. First, the action will enable DSAM professionals throughout the DSAM community, to increase productivity substantially in the DSAM process. Ultimately, it will enable a larger group of IDSM professionals throughout the IDSM community, to increase productivity in the IDSM process even more throughout every system's entire life-cycle.

Background. How to manage acquisition of defense systems most effectively has always been a serious problem. As defense systems became more complex, the acquisition management problem became increasingly difficult and more visible, prompting new DoD policy-makers <u>to improve management</u> of systems acquisition.

In the early 1960s, Defense Secretary McNamara instituted the Total Package Procurement (TPP) process. New Deputy Secretary of Defense Packard, issued DoD Directive 5000.1, "Acquisition of Major Systems" in 1971 to establish new policy with emphasis on competent people, rational priorities, clearly defined responsibilities and adequate authority for decentralized acquisition of approved defense systems. Another new Deputy Secretary, Carlucci, instituted the DoD Acquisition Improvement Program in 1981. Other new Defense Secretaries and Deputies, and new top policy makers in the military services since 1947, have also made significant changes in policy, organization-structure and processes to improve management of the DSAM process.

In 1985, President Ronald Reagan issued Executive Order 12526 to establish the President's Blue Ribbon Commission on Defense Management. It was tasked to study defense management policies and procedures, focusing on seven particulars, the first of which was "Review the adequacy of the defense acquisition process." The Commission, chaired by David Packard, and known as the Packard Commission, submitted its final report, *A Quest for Excellence: Final Report to the President*, on June 30, 1986.[3] Perhaps the most broad based analyses of the defense acquisition process ever, it included recommendations on three major management environments, in which the acquisition process operates and with which it interacts, and "A Formula for Action,"[4] beginning with the following quotation, and comprising nine major recommendations on organization and

procedures of the acquisition process itself.

> We believe it is possible to cut this cycle (ten-to-fifteen-year acquisition cycle) in half. This will require radical reform of acquisition organization and procedures. It will require concerted action by the Executive Branch and Congress, and the full support of the defense industry. Specifically, we recommend that the Administration and Congress join forces to implement the following changes in the acquisition system.

Coincident with the highly-visible increasing need to improve management of systems acquisition, there has also been a long-standing less-recognized need—to increase productivity substantially in the DSAM process. Seeking insights for improvements that would significantly increase productivity of the overall DSAM process, we have observed and analyzed the above and other major acquisition improvement efforts.

Most have recommended specific changes in organizational structures, policies, processes and procedures to improve management of systems acquisition. However, most past improvements based on these recommendations have not increased productivity in the DSAM process substantially.[5] The Packard Commission goal of cutting the acquisition cycle in half is one of several measures of increasing productivity substantially, but their record on achieving this goal is still out since all of their recommendations have not yet been fully implemented.

The need to increase productivity substantially in DSAM processes is even more critical today. The Soviet nuclear threat is gone, but the number of nations with nuclear capability is growing. We live in an increasingly unstable world whose threats have yet to be identified. Yet, the DoD is downsizing, and resources for new defense systems are being significantly reduced. With growing emphasis on deficit reduction and increased domestic spending, there is pressure for even greater reduction in defense spending. As a result, setting acquisition priorities is shifting emphasis from new system acquisitions to fielded system modifications and upgrades, or other less costly ways to meet any, yet undefined, threat to our national security.

We face a critical national security problem: How to get more defense output from less input? The only way to get more useful and quality defense system output, from shrinking defense resources input, is to increase productivity substantially in the DSAM process. Increasing productivity substantially has been the objective of our research, beginning in the mid-seventies,[6] and is the objective of this research paper.

The Packard Commission's *A Quest for Excellence,* like earlier acquisition improvement efforts, also recommended specific changes in acquisition organization and procedures. However, the Commission's "Formula for Action" was more comprehensive, including actions by the Congress and industry as well as by DoD and the Executive Branch. More important, Chairman Packard provided significant new insights for achieving excellence in acquisition which he stated in his Foreword to the report. Following are two excerpts from his Foreword.[7]

> In any large organization, policies must be executed through discrete structures. In the large, complex enterprise of national defense, this requires that we cultivate resilient *centers of management excellence* dedicated to advancing DoD's overall goals and objectives.

> Excellence in defense management will not and can not emerge by legislation or directive. Excellence requires the opposite—responsibility and authority placed firmly in the hands of those at the working level, who have knowledge and enthusiasm for the tasks at hand. To accomplish this, ways must be found to restore a sense of shared purpose and mutual confidence among Congress, DoD, and industry. Each must forsake its current ways of doing business in favor of a renewed quest for excellence. (underlines for emphasis)

We believe, and will show how his insights can enable management improvements that can increase productivity of the DSAM process substantially.

Purpose and Scope. The primary purpose of this paper is to summarize or identify enough of a nearly complete set of concepts (space does not permit otherwise) needed to understand the critical need for, and large

payoff from applying new IMT to implement the set of concepts. This can provide productive systems and aids for professionals in DSAM/IDSM *centers of management excellence* throughout government, industry and academia.

We have three objectives. All require DoD action to implement.

- Begin now to develop a two-level DSAM K&I Locator System—to increasingly enable timely selective access, by any DSAM professional, to DSAM K&I when the professional needs relevant K&I in a job or for a task at hand.
- Begin now to develop an Integrated DSAM Research & Information (R&I) Process System—to speed filling identified voids, and to maintain the relevancy, currency and accessibility of the body of DSAM K&I that professionals need to access.[8]
- Plan now to build on these evolving DSAM K&I Locator and R&I Process Systems, and to expand them to IDSM K&I Locator and R&I Process Systems, and thus increase productivity even more in an IDSM process that covers every defense system's entire life cycle.[9]

Together, these will increase the productivity of all DSAM professionals, and thus, increase productivity substantially in the DSAM process; and ultimately, increase productivity even more throughout a seamlessly integrated IDSM process—for acquiring and fielding defense systems, maintaining and upgrading them throughout operational employment, and finally disposing of them in an environmentally suitable manner.

Given the domain of the DSM life-cycle, **the objective of integrated defense systems management** (i.e., the **IDSM process**) for any system should be: to not only acquire and field a QUALITY hardware system (operationally effective and suitable for intended use[10] at affordable cost), but also to maintain this QUALITY in the integrated "total" man-machine system throughout its operational employment, and finally, to assure its environmentally suitable disposal.

This IDSM objective can only be achieved by seamlessly integrating the present different stages of defense systems management (thus eliminating costly between-stage transitions) throughout the life cycle of every system. Three stages that must be seamlessly integrated are:

- DSAM, Acquisition Management through each system's initial deployment.
- OESM, Support Management through each system's operational employment.
- DSDM. Disposal Management in an environmentally suitable manner.

Achieving this IDSM objective will require networks of IDSM Process Systems; and to support them, an IDSM K&I Locator System. But first, we must focus on the underlying concepts and the conceptual framework for achieving the initial objective—to develop a DSAM K&I Locator System that will improve K&I support of DSAM Process Systems. Then, we can build upon and extend this conceptual framework, and increase productivity substantially throughout the IDSM process. We use the acronym DSAM/IDSM when discussing concepts applicable to both processes.

Since all of these concepts cannot be discussed completely in this short paper, numbered references in the Endnotes provide *additional detail about both the concepts we* summarize or identify, and those omitted entirely due to space limitations. Some earlier concepts have been modified by later developments (e.g., by tremendous advances in IMT since we began our research in the mid-seventies). Thus, a current concept based on existing IMT may differ somewhat from an earlier version that was based on our projections for emerging technologies.

UNDERLYING CONCEPTS

In this section, we summarize or identify several underlying concepts which we believe will help understand the DSM (DSAM and IDSM) Knowledge Systems concepts outlined in the next section, and the critical need to start now to implement the concepts.

Crucial Consequences. No one person or organization can have experiential knowledge of all aspects of the immense, extremely complex and dynamic DSAM process—larger and more complex than any management process in the business world. Each DSAM professional, no matter how expert in his or her particular DSAM field, function and subprocess, suffers from two

crucial consequences of the inherent large scope, extreme complexity and "interactiveness" of the DSAM process, and will suffer more in the future larger IDSM process. The crucial consequences are:

- False perceptions of the whole DSAM or IDSM process, resulting from experience in only a few DSAM or IDSM subprocesses. The kinds of perceptions are important because perceptions,[11] not reality, trigger change and guide DSAM decisions and action.
- Misunderstood communications, among DSAM professionals from different fields, functions and with different working jargon, which result from lack of a common DSAM language to assure cross-field and cross-function communications with understanding.

Both of these consequences are exacerbated by high turnover of professionals in key jobs, due to promotions and career advancement moves, and particularly, by concentrated high turnover due to changes in Administrations every 4 or 8 years. New Administrations bring new teams of policy makers with new national goals they promise the electorate to emphasize. They also bring different perceptions of the DSAM process and its importance to national security.

The combined results of these inherent consequences and exacerbating turnovers, are wasteful zigs and zags in major DSAM policy, and costly, schedule-delaying reworks in programs, system designs, production processes, etc. in the DSAM process.

Considering all of the above, our analysis indicates that developing and maintaining truer perceptions of the whole DSAM process, and also developing a more common DSAM language, are prerequisites for success in future efforts to increase productivity substantially in defense acquisitions.[12]

Prerequisites for DSAM Excellence. Given the truer perceptions and common language prerequisites, we begin with, and will continue to build upon, Chairman Packard's discerning insights, quoted above. These insights concern defense management in general and particularly the DSAM process. They will be equally applicable in the future ISDM process.

- A prerequisite requirement for excellence in management of the large, complex enterprise of national defense is that DSAM/IDSM policy-makers **must** cultivate ***centers of management excellence*** dedicated to advancing DoD's overall goals and objectives.
- **Excellence** in management of the DSAM/IDSM process **requires** that those at the working level have firm responsibility and authority, and also **knowledge**, and enthusiasm **for the tasks at hand**.

The first two requirements for excellence in management--responsibility and authority at the working level--can be met through specific organization structure and policy recommendations. Reorganizing structures and changing policy have been the traditional focus of past efforts to improve the DSAM process. Also, staff selection and motivation have been the traditional means for assuring the enthusiasm. But these are not sufficient for excellence! They do not meet the requirement of "knowledge for tasks at hand."

Packard's perceptive "requirements for excellence" insights raise "what is necessary" and "how" questions. For example:

1. What is necessary for productive cultivation and maintenance of (DSAM, ultimately IDSM) *centers of management excellence* which:
   - can best assure timely, coordinated, effective execution of centralized DoD systems management policies through necessarily discrete structures,
   - operate in ever-changing political, economic and international environments (e.g., post-Soviet environment) that may necessitate changes in the centralized DoD policies, and
   - can continually coordinate their respective policy execution efforts with other *centers*, in order to contribute effectively toward achieving the current national defense and DoD goals and objectives.

2. Given successful cultivation and maintenance of DSAM *centers of management excellence* (hereafter often called *centers*):
   - How best can the most relevant DSAM K&I *centers* be quickly located?
   - How best assure these K&I *centers* can be selectively accessed by any DSAM professional to get timely DSAM K&I relevant to a task at hand?

3. Concerning Packard's requirement of

knowledge for tasks at hand:

- How best assure that all K&I needed for tasks at hand are available?
- When not available, how to expedite the needed K&I to the professional who identified it, and also assure it is added to fill the void in the body of K&I, and maintain it for future timely access?

Before answering these questions, we need to consider other building block concepts developed in our research that should help, both in understanding the DSAM and IDSM knowledge system concepts generated by answers to these questions, and in implementing the concepts. Then we will continue our examination of means for meeting these Prerequisites for Excellence.

Productivity Elements Framework. We developed a DSAM-process productivity elements framework concept[13] as an analytical tool. Its purpose is to help systematically identify and consider all productivity elements that can influence the DSAM process output, in order to concentrate on those elements that promise largest increases in productivity. Our current productivity element framework[14] includes three traditional organizational elements objectives, processes and structures and two types of DSAM process inputs (1) tangible resources, and (2) intangible job- and task-related DSAM K&I resources. The intangible K&I resources, great contributors to increased productivity, have usually been overlooked in past improvement programs. Two more elements, the environment and culture of the acquisition process, were added because of the Packard Commission report on how much the current environments of defense acquisition and the present defense management culture, were and still are, adversely affecting the acquisition process.

DoD Productivity Initiatives. We used the productivity framework in 1989 to identify new opportunities to increase productivity of DSAM professionals.[15] Based on results from the 1988 review of past efforts to improve the acquisition process,[16] we concluded that DoD initiatives in three interdependent DSAM areas could expedite improvements in the DSAM process. The three DoD initiatives are:

1. Continue increasing the integration of major DSAM processes.
2. Manage constructive change of defense acquisition environments, and motivate improvements in the present defense management culture.
3. Provide DSAM knowledge system aids that can increase productivity of DSAM professionals.

DSAM Knowledge System Concept. Figure 1 is a simplified model of an integrated Research & Information (R&I) DSAM process.[17] It represents a partial answer to the last two questions above under Prerequisites for DSAM Excellence. This process is required to support the cultivation, maintenance and ongoing operations of all DSAM *centers* in the defense acquisition community. The databases represented by some of the boxes may be distributed and in different locations. The numbered arrows indicate four processes integrated into the R&I process. Arrows outgoing from the DSAM professional, who needs relevant DSAM (K&I), enter four boxes. These boxes represent four categories of DSAM R&I databases, which may be components of larger databases in organizations located throughout the DSAM community. These databases are important elements of a DSAM K&I Locator System which we discuss later.

Any professional could use this integrated process to get particular DSAM K&I for a task at hand. First, the professional would use DSAM K&I Locator System to query (1) DSAM Documents databases for K&I which have been documented, and also (2) DSAM Expertise databases to locate experts, individuals or organizations, available for consultation. If both queries yield nothing useful, the professional would check (3) Ongoing DSAM Research Projects databases of DSAM research organizations to identify principal investigators who have the required, but as yet unpublished knowledge. Success in any of these queries would close the loop by expediting the sought K&I to the professional, enabling him or her to complete the task at hand.

If no query of these three categories of databases produces the required DSAM K&I, the professional would register the sought item of K&I (as a void to be filled in the body of DSAM K&I, and therefore, a research requirement) in the Validated DSAM

Issues/Problems (VDIP) database. The K&I item needing research would be entered into the Projects Being Evaluated (PBE) file of the VDIP database, for evaluation by competent authorities. If they evaluate it as a sound requirement for new DSAM K&I and give it a research priority, the requirement would be transferred to the Validated Candidate Projects (VCP) file of the VDIP database as a validated project for DSAM research with an assigned priority. One centralized DoD VDIP database would serve all DSAM research organizations in the DSAM acquisition research community.

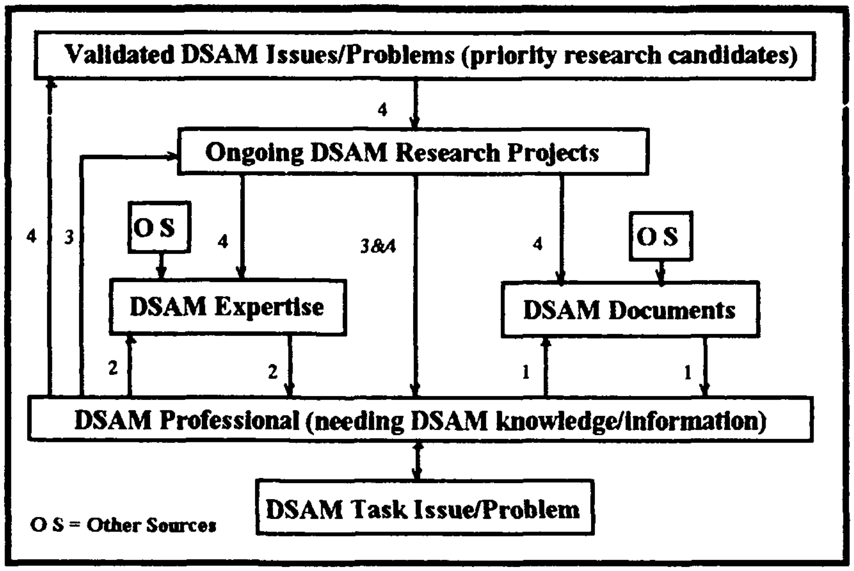


Fig 1. Integrated Research and Information (R&I) Process

If the professional's requirement receives a high priority, a DSAM research organization which has an interest in the validated candidate, expertise in the DSAM area, and the necessary resources, would select and transfer the candidate project to its own Ongoing Research Projects database, and begin research. After completing the project, the principal investigator would: (1) provide the new K&I directly to the initiator professional who needs it to complete a task, (2) publish the research results to fill a void in the body of DSAM knowledge, and (3) finally add the published report to a DSAM Documents database for future retrieval when needed by another professional.

Implementing this integrated R&I process, a DSAM Knowledge System concept, will best assure that job- and task-relevant DSAM K&I are available for access by any professional, and will expedite development of new K&I to fill voids and maintain a useful body of DSAM K&I for access when needed.

Prerequisites for Excellence Continued. Neither Chairman Packard, nor the 1986 Commission report, considered how or where to cultivate, or how to maintain, *centers of management excellence*. Nor did they consider how to assure that those at the "working level" could always get timely knowledge for each task at hand.

Initially we sought to understand the new aspects of Packard's requirements for excellence by asking the three questions stated above under Prerequisites for Excellence.

Then, seeking answers to the first "what is necessary" question, we focused on three interrelated DSAM and IDSM issues, seeking near-term DSAM insights with early payoff, which could be extended within an ultimate IDSM framework:[18]

- What management knowledge (and information) is required for excellence to emerge, and what conditions are necessary for excellence to flourish?
- What is the domain of Integrated Defense Systems Management (IDSM) when systems management is extended beyond DSAM to include all of a defense system's life cycle?
- What is necessary to integrate the three now separate DSM stages into an Integrated-DSM (IDSM) process over each defense system's life cycle?

Knowledge Required by Centers. To answer the first question, we focused on how to meet Chairman Packard's requirements for *centers for management excellence* that cannot be filled by current organization and management practice. There are two:

- How to develop and maintain specialized know-how for application by any DSAM professional when needed.
- How to facilitate each professional's exploration of new and better ways to get his or her job done.

The first can be met by providing each

center with systems and aids for timely, selective, *on-demand*, access, by any member, to relevant sources of any needed specialized know-how. In addition, the aids must support exploration of external sources for new (to the individual) and better ways to get their job done. How to develop knowledge systems and aids which can do both will be discussed later after some concepts that show what is involved are visited.

The answer to "where to cultivate" *centers of management excellence* in order to provide all DSAM professionals access to these sources is that they must be cultivated and maintained at every source of DSAM K&I, and every point of DSAM decision and action, throughout the DSAM community (in government, industry and academia), and interconnected by knowledge systems. How to do this will also be discussed.

DSM Concept. The Packard Commission showed little concern about program management of defense systems during the rest of a system's life cycle. Our 1990-1991 analysis of the issues listed above under Prerequisites for Excellence, indicated that extending the domain of defense systems management throughout the entire life of each defense system would give significant payoff- -in enhanced operational suitability and operational effectiveness of each defense system, in dollars saved, in more productive integrated defense systems management practice, and in improved education.

We used "systems thinking" to define and discuss the Defense Systems Management (DSM) domain that included and extended beyond DSAM to cover each system's life cycle. We discussed the boundaries of the DSM domain, and how they spanned both a great managerial hierarchy and a time line (DSM time line). The managerial hierarchy ranges from establishing all national defense policies that involve defense systems, down through numerous organizational hierarchies to the management level(s) where these policies are finally executed.

The upper part of Figure 2 portrays our new concept of a Defense Systems Management (DSM) view of a defense system's life cycle, with:

- Three consecutive stages: DSAM, OESM, and DSDM.
- Concepts of several categories of DSM K&I Process Systems that we believe are required to support the *centers* in each stage. There are many more K&I process systems. Many already exist, others should be developed, and all need to be integrated. (See K&I Process Systems below.)
- Some kinds of DSM K&I that a DSM K&I Locator System could provide.

DEFENSE SYSTEMS MANAGEMENT (DSM) over the Life Cycle of Each Defense System		
Acquisition DSAM Stage	Operational Employment Support OESM Stage	Disposition DSDM Stage
DSM K&I (knowledge & information) Process Systems		
DSAM K&I DT&E K&I--- M-MIM K&I-- L&ISM K&I--	OESM K&I - OT&E K&I --------------- M-MIM K&I ---L&ISM (ILSM & ISM) K&I---	DSDM K&I ---- ILSM K&I
Kinds of K&I Provided by DSM K&I Locator Systems		
Milestones 0–IV Phases I-IV FMPT&S Prog L & IS Planning	Operational Test & Evaluation Man-Machine Integration Integ Log Spt & Infrastructure Support	Foreign Military Sales Recycle/Salvage Environmental clean up
INTEGRATED DEFENSE SYSTEMS MANAGEMENT (IDSM) IDSM over the Life Cycle of each Defense System can be achieved by interconnecting all Centers of Management Excellence, and all DSM Knowledge Systems, with a Standardized Common IDSM Language		

Fig. 2 DSM (Defense Systems Management) & IDSM

The boundaries between DSM stage processes are the result of some significant differences in the "culture" and objectives of the professionals working in each process. Disconnects and misunderstandings in communications, and discontinuities in management processes, result when professionals working in a particular process don't have a completely common language. Integrated DSM will be difficult, if not impossible,

without common concepts and a common working language.

IDSM Concept. The last part of Figure 2 portrays the Integrated-DSM (IDSM) view of a defense system's life cycle. Implementing this integrated view will involve evolutionary integration of the standardized common language (working terminology) of each former DSM stage into one standardized common IDSM language. This IDSM language would enable development of DSM knowledge systems, using IMT, to interconnect all *centers* and all IDSM Knowledge Systems throughout the IDSM community, thus enabling timely access to relevant IDSM K&I, and communication of these K&I throughout the IDSM community (i.e., clear and timely K&I feedback and "feedforward" across former DSM stage boundaries).

This IDSM concept requires and depends on an "informational" integration of all K&I required for management tasks in any former DSM stage. No other practical alternative is available. Changes in organizational structure may correct some authority-responsibility deficiencies (while creating others) but they do not solve the problems of assuring timely access by IDSM professionals in any part of the IDSM life cycle, to K&I that are relevant for tasks at hand.

In the complex bureaucracy concerned with national defense, IDSM cannot be achieved organizationally. But, IDSM can be achieved operationally—by applying new IDSM Knowledge Systems concepts and David Packard's concept of *centers of management excellence*, to implement "informational" integration of DSM K&I. [19]

IDSM can be achieved by providing professionals in each *center* throughout the IDSM community, timely access to IDSM K&I that each requires for five main purposes:

- To continually know and have a common understanding of the goals and objectives of DoD's centralized policies.
- To clearly coordinate each center's respective efforts in its area of responsibilities, toward coordinated execution of the commonly understood centralized defense systems management policies, in order for all to contribute productively to achieving DoD's goals and objectives.
- To develop and maintain job- and task-related specialized know-how.
- To explore new and better ways for getting his or her job done.
- To perform with excellence any management tasks at hand.

We should note that professionals in all *centers* throughout the present DSAM, OESM, and DSCM stages also need K&I for the same five purposes—to interact with their knowledge systems which help them perform their respective functional processes.

DSAM Knowledge Systems

Having used Figure 2 to help explain the ultimate potential of IDSM, we turn now to our first objective: to urge DoD action to begin developing a DSAM K&I Locator System that can locate and access the kinds of K&I portrayed in the left DSAM part of Figure 2. But first a quick look at the other kind of knowledge system, process systems, and their relationship to the locator system.

DSAM K&I Process Systems. There are many process systems but only one locator system. Space does not permit summarization of DSAM K&I Process Systems except to note that these systems largely determine the kinds of K&I that DSAM professionals must locate and selectively access. The professionals require K&I mainly to interact with—provide K&I inputs to and receive K&I from—DSAM K&I Process Systems, and to operate or design, develop and improve process systems needed to help the professionals achieve the objectives of their DSAM subprocesses.

The Integrated DSAM R&I Process System for maintaining the body of DSAM K&I is an example of K&I process systems. Three other examples dealing with systems management processes are identified in Figure 2.

- DT&E (Development Test & Evaluation) K&I Process System(s).
- M-MIM (Man-Machine Integration Management) K&I Process System(s).
- L&ISM (Logistics and Infrastructure Support Management) K&I Process System(s).

These three examples are based on processes documented in DoD Instruction 5000.2. M-MIM represents our process

system concept of integrating the man (people) processes—forces, manpower, personnel, training, human factors, safety, etc. —together in man-machine integration systems. The example systems also generate and transmit K&I, as well as receive K&I, for management of specific defense system programs, or for higher level management applicable to many defense systems. We believe that these process systems should expedite K&I across DSM stage boundaries (indicated by dashed lines in Figure 2) in order to support progressive integration of the now separate DSM stage processes, toward the ultimate IDSM process.

DSAM K&I Locator System. Thus far, we have looked at several factors that affect the kind of K&I systems and aids which must be developed and maintained to support the cultivation, emergence and maintenance of DSAM *centers* throughout the DSAM community. The review indicates that the DSAM K&I systems and aids must be able to provide, to the professionals in these DSAM *centers*, on-demand, timely, selective access *to DSAM K&I that are relevant to any* of the five main purposes identified above under the IDSM Concept.

These stringent on-demand, selective, relevant K&I access requirements for maintaining *centers* throughout the DSAM community fly in the face of harsh reality. The enormous body of DSAM K&I is distributed widely—in many collections:

- of different categories of DSAM K&I (contracting, systems engineering, etc.),
- with many different formats (reports, books, articles, electronic data, CD-ROM, human expertise), and
- assembled to support many different purposes and functions in DSAM process.

These collections are located in thousands of different organized DSAM-area K&I SOURCES (e.g., in special libraries, repositories, archives, databases, centers of expertise, information analysis centers).

Considering both the stringent K&I access requirements, and the size and wide distribution of the body of DSAM K&I:

- **How best can all of these items of DSAM K&I be identified, organized, classified, and indexed, for selective, on-demand, access and retrieval, by DSAM professionals in *centers* throughout the DSAM community?**

Our answer to this question after much research analysis is:

- **By beginning to implement a two-level DSAM K&I Locator System,** with:
  - a macro-level DoD DSAM Information System. Its purpose will be to help DSAM professionals quickly locate known organized SOURCES of DSAM-area K&I that likely contain K&I which are relevant to the DSAM professional's purpose.
  - thousands of micro-level DSAM-area Knowledge Systems—at least one per SOURCE. The purpose of each knowledge system, after the DSAM professional selects a likely relevant SOURCE, will be to provide timely, selective, on-demand, access to specific K&I in that SOURCE, which are relevant to the professional's immediate purpose.

The following summaries are meant to help understand the two-level Taxonomy-Glossary standardized structure for Information and Knowledge Systems, realize the usefulness and key roles of both levels, and recognize the critical need for DoD to act now to implement the DoD DSAM-SIS concept, and to encourage evolutionary implementation of the DSAM-area-SKS concept.

DoD DSAM Information System. The upper level DoD DSAM-SIS (DoD DSAM Structure & Information System) is the DoD DSAM Information System. This Information System is structured (its DSAM-area and location data organized, classified, and indexed for retrieval) by a macro-level DoD DSAM Taxonomy-Glossary of the body of DSAM knowledge (summarized below). Implemented top-down, the DoD DSAM-SIS can serve many purposes. Initially, the DoD DSAM Information System part of the DSAM-SIS will provide any DSAM professional the name and location of all known major organized SOURCES of particular categories of DSAM-area K&I.

The DoD DSAM Taxonomy-Glossary (the macro-level DSAM Structure part of the DSAM-SIS) will be standard throughout the DSAM community, and thus, will interconnect all DSAM K&I Knowledge Systems into an integrated network of DSAM-IKS (Integrated Knowledge Systems) that DSAM

professionals will be able increasingly to access directly to get needed relevant DSAM K&I.

DSAM-area Knowledge Systems. The lower level DSAM-area-SKS (DSAM-area Structure & Knowledge Systems) comprise thousands of micro-level DSAM-area Knowledge Systems—one DSAM-area Knowledge System for each major organized SOURCE that is included in the DoD DSAM Information System.

Each DSAM-area Knowledge System will be structured by its respective DSAM-area Taxonomy-Glossary (or any other indexing and retrieval system that each SOURCE now has until it develops a Taxonomy-Glossary) for organizing, classifying, indexing, storing, and retrieving (selectively accessing) specific items of its DSAM-area K&I.

DSAM Knowledge Structure. The structure of a body of defense systems management knowledge involves relationships among preferred key terms of the language used in communicating and in using that knowledge. The structure is not initially unique, may be somewhat arbitrary, and is divided into a macro and micro level because of the large size, wide distribution and multi-discipline nature of the body of DSAM knowledge. However, the structures (terms and relationships) adopted for both levels of DSAM Taxonomy-Glossaries must be useful, used, and accepted by the professionals. Only then will the Taxonomy-Glossaries be useful, accepted and used by DSAM professionals for assembling, organizing, classifying, storing, indexing, accessing, and communicating their professional knowledge in systems management activities.

To be most useful, and both clear and unambiguous, our research indicates that the structure must include two elements: a DSAM Taxonomy and an integrated DSAM Glossary (with definition(s) or description of each term in the Taxonomy).[20] The glossary serves two purposes: to assure common understanding and use of each term in the taxonomy, and to promote a common DSAM language for managing defense system acquisition. A DSAM Taxonomy without an integrated Glossary implicitly assumes a completely common language (working jargon) among all professionals throughout the DSAM community. Not true, hence the integrated DSAM Glossary.

DSAM Taxonomy-Glossary. Webster defines a taxonomy as "The systematic distinguishing, ordering and naming of type groups within a field." The taxonomy of a field's knowledge is the bootstrap by which professionals in any field inventory their professional knowledge, identify voids to be filled, organize research to fill them, achieve professionalism, plan integrated operations, increase productivity, and advance their field's contribution to society. Our field is the body of DSAM knowledge.

The DoD DSAM Taxonomy-Glossary that is developed will be the macro-level umbrella Taxonomy of all DSAM areas of this whole body of knowledge. This umbrella DSAM Taxonomy will connect down to each micro-level DSAM-area Taxonomy as it is developed, thus providing a complete, integrated, hierarchical DSAM Taxonomy for that area of DSAM knowledge.

This umbrella Taxonomy will interconnect all of its named DSAM areas to show relationships, and so, will link each DSAM-area Knowledge System as its development is completed, into the integrated DSAM-IKS network. Ultimately, when all micro-level DSAM-area Taxonomy-Glossaries are developed (for all DSAM-area Knowledge Systems), and connected to the macro-level DoD DSAM Taxonomy-Glossary, the combined macro-level and micro-levels would be a complete DSAM Taxonomy-Glossary of the body of DSAM knowledge.

Recommended DoD Actions

Under DoD Productivity Initiatives above, we listed three general initiatives that our 1988-89 analysis indicated DoD should pursue to expedite improvements in the DSAM process. The actions recommended below focus primarily on the third productivity initiative because systems and aids that can increase productivity of DSAM professionals, promise a high-payoff use of DoD resources. They focus on the first two objectives stated at the beginning of the paper, because development of the DSAM K&I Locator and DSAM R&I Process Systems must get underway before acting on

the third objective.

DoD Actions to Start Locator System. Three actions are necessary to start developing the macro-level DoD DSAM-SIS and its Information System which will provide locations of DSAM-area SOURCEs. The fourth will support evolutionary development of micro-level DSAM-area Knowledge Systems to increasingly provide DSAM professionals timely selective access to relevant K&I, after a likely SOURCE is chosen. The actions are:

1. Start development of a prototype macro-level DoD DSAM Taxonomy (first the part of DSAM-SIS) which can be field tested by DSAM professionals and improved in structure and scope.[21]

2. Simultaneously, use the terms in the Taxonomy to begin integrated development of the DSAM Glossary to assure precision.[21]

3. Start developing the second part of the DoD DSAM-SIS—(i.e., the DoD DSAM Information System). As the DSAM-area structure of the prototype DoD DSAM Taxonomy-Glossary begins to emerge, begin identifying major organized SOURCES of DSAM-area K&I (e.g., special libraries, repositories, databases, centers of expertise). Use the DoD DSAM Taxonomy-Glossary to classify, index and enter each SOURCE with its data into the growing DoD DSAM Information System database. Also use the Taxonomy-Glossary to develop a "DoD Thesaurus of Sources of DSAM Knowledge and Information." Then, every DSAM professional can use the Thesaurus to identify and contact those SOURCES which, in their respective organized DSAM-area collections, most likely have DSAM K&I that are relevant to the professional's immediate purpose.

4. Encourage every DSAM-area SOURCE to develop a micro-level DSAM-area Taxonomy-Glossary for classifying, indexing, storing and retrieving the K&I in its DSAM coiiection. This will enable selective acuess, by any DSAM professional, to K&I in the collection that are relevant to the professional's immediate purpose.

DoD Actions to Start R&I Process System. Two actions are necessary to start two DoD databases which, together with the DSAM K&I Locator System, will comprise the DSAM R&I Process System for integrating the DSAM research and information processes:

1. Start development of a DoD Validated DSAM Issues/Problems Database.

2. Start development of a DoD Ongoing DSAM Research Projects Database.

Other DoD Actions. DoD should also begin two other actions[22] that support the first two general DoD initiatives cited above. The actions are: develop an integrated hierarchical DoD Acquisition Strategy to help coordinate, at all levels, decentralized execution of defense acquisition policy to achieve DoD acquisition objectives; and conduct a regular Packard-Commission-like review of the defense acquisition process every four years to get broad based objective information, for achieving constructive change in both the acquisition environment and the acquisition process, and to support a more orderly transition to new Administration DoD policy makers. Space does not permit summarizing these actions, but earlier summaries are available in the Endnote reference.

SUMMARY

Although space limitations required omission of several concepts, we believe the concepts that were summarized or identified should achieve our purpose. It is to help understand the present critical need for, and large payoff from using IMT to implement the complete set of concepts, particularly the key concepts stated earlier in the objectives and included in Recommended DoD Actions above.

Implementing these concepts will increase productivity of all DSAM professionals in centers of management excellence, and thus increase productivity substantially in the DSAM process. Ultimately, it can increase productivity even more throughout a seamlessly integrated IDSM process that covers every defense system's entire life cycle.

ENDNOTES

[1] The terms DSAM/IDSM professional, as used in this paper, include any government, contractor, academic or other knowledge worker who uses DSAM or IDSM knowledge and information professionally in his or

her job in support of a DSM process.

[2] Information management technologies (IMT) as used in this paper, includes most of what is normally defined as Information Technology (IT), and also, all technologies that use IT in the generation, assembly, classification, processing, dissemination, selection or retrieval of knowledge and information for use in management (e.g., library and publications technologies).

[3] President's Blue Ribbon Commission on Defense Management. 1986. *In Search of Excellence: Final Report to the President* (hereafter referenced as *Packard Commission Report*). Washington, DC.: U.S. Government Printing Office, June, 115 pages.

[4] Packard Commission Report, pp. 52-71.

[5] Mosier, Andrew P. 1988. "Past Acquisition Improvements: Not Sufficient." *Program Manager: The Journal of the Defense Systems Management College* (hereafter referenced as *Program Manager*) 17 (May-June) pp. 42-57.

[6] Mosier. 1985. "A Proposal for Research to Improve the Productivity of Defense System Acquisition Managers throughout Government and Industry." *Proceedings, 1985 Federal Acquisition Research Symposium*, pp. 5-12. See referenced Endnote 3 for early research.

[7] Packard Commission Report, pp. xi, xii.

[8] Mosier. 1989. "Expediting Acquisition Management Knowledge and Information to Centers of Management Excellence." *Proceedings, 1989 Acquisition Research Symposium*, pp. 301-306.

[9] Mathias, John R., and Mosier, Andrew P. 1991. "Achieving Excellence in Management of Defense Systems." *Proceedings, 1991 Federal Acquisition Research Symposium*, Vol. II, pp. 223-236. See pp. 227-228. (Note: The last two pages of this paper, inadvertently omitted from the *Proceedings*, should be available from DSMC. If not, Dr. Mosier can provide them as pages 236a and 236b.)

[10] For definitions of operational effectiveness and operational suitability, see DoD Instruction 5000.2, *Defense Acquisition Management Policies and Procedures* (February 23, 1991), Part 15, Definitions, p.15-13.

[11] Mosier. 1988. "Past Acquisition Improvements: Not Sufficient." pp. 47-50.

[12] Mosier. 1987. "Getting the Jump on DoD Productivity." *Program Manager 16 (July-August) pp. 18-26*

[13] Ibid. 24-25.

[14] Mosier. 1989. "New Initiatives and Concepts for Increasing Acquisition Productivity," *Program Manager* 18 (March-April) pp. 24-34. See p. 24 for productivity elements framework.

[15] Ibid. pp. 24-26 for DoD Initiatives. Lack of space precluded summary of new concepts (pp. 26-28), that would be useful in understanding DSAM Knowledge Systems concepts.

[16] Mosier. 1988. "Past Acquisition Improvements: Not Sufficient." pp. 42-57.

[17] Mosier. 1989. "Expediting Acquisition Management Knowledge and Information to Centers of Management Excellence." pp. 303-306.

[18] Mathias and Mosier. 1991. "Achieving Excellence in Management of Defense Systems," pp. 225-231.

[19] Ibid. pp. 230-233.

[20] Mosier. 1989. "DoD Actions to Increase Acquisition Productivity." *Program Manager* 18 (May June) pp. 60-72. See discussion of DSAM Taxonomy-Glossary, pp. 62-66.

[21] Ibid. pp. 71.

[22] Ibid. pp. 67-68, 70-71. See for summary of Other DoD Actions recommended .

COST RISK ANALYSIS: STATE OF THE ART REVIEW

Dr. Gerald R. McNichols
Jason Dechoritz
Management Consulting & Research, Inc.
5113 Leesburg Pike, Suite 509
Falls Church, Virginia 22041
(703) 820-4600

ABSTRACT

There are multiple approaches to analyzing risk in a weapon system program. The general steps of a cost risk analysis procedure will be described:

- Preview - identify key risks through execution of five tasks:
  - Define the purpose of the risk analysis.
  - Review available information concerning the program.
  - Break the program into its components at some specified level of detail (i.e. the Cost Element Structure-CES).
  - Develop a list of risk areas.
  - Review any other risk analyses that may pertain to the program.

- Perform - develop the risk assessment through completion of five tasks:
  - Develop measurement standards (percentage of cost for the Low, Most Likely, and High applied to the Most Likely Cost Estimate).
  - Collect available data for each identified risk area (i.e. interview the Technical Risk team members as well as the Cost Estimating team members).
  - Determine the range of possible outcomes for each element of the CES (i.e. develop a probability distribution).
  - Conduct the initial modeling and calculations.
  - Identify risk items needing additional data or other processes or procedures for completion of the assessment.

- Present - Display the results in a manner that allows reviewers to understand the analysis.

The presentation will describe currently used alternative methodologies including simulation, method of moments, and analytical formulas to complete the risk analysis process. These are too lengthy to include in this paper.

INTRODUCTION

Risk assessment is a comprehensive and structured process where the risk of a particular course of action is estimated. We must understand the program well enough to identify unplanned and unknown events potentially facing a program, their nature, their probability of occurrence, and the consequences of their occurrence. In mathematical terms, risk analysis models determine and use probabilities and probability distributions to assess the combined impact of risk on the program. Every model manipulates the data differently. Selection of risk areas and collection of data for input into a selected model and the subsequent presentation of the model's outputs are the core activities involved in risk analysis.

Basic Modeling Approaches. Risk analysis is an important factor in the decision making process for complex systems. The process of risk analysis provides additional insight for decision makers through the collection and interpretation of quantitative data. It is important to remember that decisions facing managers of systems will be made under conditions of less than perfect knowledge about the future. No analyst nor program staff can ever assemble the perfect knowledge base about the program. A process to make quantitative models to link expert judgements, historical facts, and program plans to possible outcomes needs to be established. Figure 1 shows there are three basic stages in approaching the risk analysis:

- preview,
- perform, and
- present.

THE THREE COST RISK ANALYSIS STAGES

PREVIEW

- Define the purpose of the risk analysis
- Review available information concerning the program
- Determine components to be analyzed
- Develop list of risk areas
- Review other pertinent risk analyses

PERFORM

- Develop measurement standards
- Collect data for risk areas
- Develop distribution information for each component to be analyzed
- Model the data
- Follow up

PRESENT

- Document the results
- Perform sensitivity analysis

Figure 1. The Three Cost Risk Analysis Stages Follow a Logical Work Flow

Selection of Model. There is no one right model to conduct cost risk analysis. Because each program office estimate uses several estimating techniques to compute the estimate, a risk analysis may have to rely on more than one risk analysis model or technique to be effective. The selection and use of a particular risk analysis model depends on the amount and type of information available for the analysis as well as model availability, the skills and availability of trained analysts, and the level

The risk analyst needs to become a source for providing information on a wide range of possible outcomes of the program. The analyst's basic task is to establish a rational model that connects probabilities developed from expert sources with program plans and alternatives. As a result of the risk analysis process, the analyst will develop a report that provides information. The analyst should be aware that the report will be used as a basis for communication between many parts of the program and with decision makers. As part of the communication process, many individuals may provide comments and other forms of constructive criticism. This form of feedback provides the analyst with a framework for revising the groundrules and assumptions comprising the risk analysis model. Some of the comments provided as feedback may not be included in a revision to the model. However, the analyst needs to provide this feedback to the decision maker, possibly in another form like sensitivity analysis or as a part of the discussion in the final report.
of information needed by the decision makers. The risk analysis model(s) selected should be able to provide Air Force and Government management with information that can be used in making better informed decisions concerning what may happen and what action should be taken.

General Risk Models. The general risk models develop cost and risk information about a program based on historical data of previous or similar programs. They use statistical relationships between cost and other parameters describing the system. Modeling techniques in this group include considering risk through the use of Cost Estimating Relationships (CERs). Several hardware firms have their own internal models. One related general risk model is the Range Estimating Program.

Stochastic/Probabilistic Models. Stochastic/probabilistic models develop probability distributions for cost elements or whole programs based on statistical, mathematical, and simulation techniques. Examples of this type of model include the Air Force Risk Model, the MCR Risk Model, the Army VERT (Venture Evaluation and Review Technique) model, PERT (Program Evaluation and Review Technique) analysis, CPM (Critical Path Method) analysis, and other sophisticated variants of these approaches. These models allow for the aggregation of cost and risk values for the entire program.

RISK ANALYSIS PROCEDURE

The cost analysis team must have a well defined plan to conduct a risk analysis. The risk analysis is a necessary component of the complete cost analysis. Regardless of the results of the risk analysis, the process and product serves to provide additional information to decision makers. Another benefit of the risk analysis is that it serves to allow informed people from all parts of the program to participate in making an estimate of the future range of outcomes facing the program. The input of experts knowledgeable about the program can be used to produce valuable information about future possible outcomes in the program. There are three basic stages in conducting the cost risk analysis. The following paragraphs discuss each of these stages.

PREVIEW STAGE. The preview stage consists of identifying key risks through five tasks. These tasks are:

- Define the purpose of the risk analysis,

- Review available information concerning the program,
- Break the program into its components at some specified level of detail,
- Develop a list of risk areas, and
- Review any other risk analyses that may pertain to the program.

Define the purpose of the risk analysis. In preparing the cost analysis plan, the team chief needs to clearly specify the objectives of the risk analysis. The risk analyst needs to understand the potential problems facing the analysis, the needs of the decision makers for information, goals of the cost analysis team, and the objectives of the risk analysis. The analyst serves as a conduit of information from expert sources to the decision maker.

(1) One fundamental consideration in defining the purpose of the risk analysis is that no future activity should be included in the risk analysis unless the analysis results could lead to a decision to alter the present course of action. Risk analysis in the cost analysis process should not be considered only as a mandatory requirement. The purpose of conducting the risk analysis must include the possibility that the results of the process may affect the present direction of the program and prepare the program to face an uncertain future.

(2) Another consideration in defining the purpose of the risk analysis is the time focus of the analysis. There may be specific areas of the program, having a specific timeframe. If the decision makers have communicated concern for a specific set of activities leading to a program milestone, the program timeframe surrounding those activities needs to be investigated. Additionally, the farther out in the future of the program life cycle an area of risk may reside, the more uncertain it will be. The analyst needs to consider the overall time schedule of events when assessing the levels of uncertainty. Generaly, an event will have more uncertainty the further in the future it occurs. Events closer to the present should have less uncertainty associated with them.

(3) The fundamental task of the risk analysis is to evaluate the program in terms of achieving its plan with the resources allocated. The cost analysis plan will include information that will form the study requirements and objectives. Understanding the detailed requirements and objectives is necessary. During the study these may change because of new information or direction, so their understanding is necessary.

(4) When establishing the risk analysis objectives, it is necessary to define the boundary between the internal program and the external factors affecting the program. When deciding what needs to be included in the risk analysis, the choices may be made subjectively. The choices will be influenced by such factors as lack of pertinent data, schedule or personnel constraints, and uncertainties associated with selecting an appropriate analysis model. Therefore, the thorough statement and understanding of the risk analysis objective is critical. Once the objective is understood, the analysis boundaries can be determined and the specific areas of risk can be evaluated. An example of an external factor that should be handled separately is funding limits, which could constrain test assets and result in schedule slippage.

(5) When stating the risk analysis objective, use past experience and knowledge of the overall defense environment and operation. Avoid stating the objective in too broad terms. Broad objective statements require many

assumptions. The use of too many assumptions may weaken the focus on known information or add unnecessary bias.

(6) When the number of assumptions increases in an analysis, a higher level of uncertainty can be introduced on the conclusions resulting from the analysis. If the risk analysis objective is stated in limited terms, it may prevent important facets of the program from being investigated.

(7) Clearly list all assumptions. The assumptions need to be justified by historical or other factual evidence. If there is no factual basis for an assumption, the rationale for requiring the assumption should be stated. There may be valid reasons for including such an assumption, including convenience in modeling, generally accepted positions affecting the program, or lack of sufficient factual basis. The statement of the background of these assumptions will highlight areas where analysis errors or bias may be introduced.

(8) Constraints on the objective are necessary for a variety of reasons. Without constraints the analysis would be open-ended, preventing a conscientious evaluation of the program's risk areas. Without boundaries the analyst may also be required to evaluate the various risk areas without considering realistic future bounds on the program. Constraints involving budget, schedule and technology need to be developed and used.

Review available information concerning the program including the current cost estimate. Determine the underlying assumptions, the Work Breakdown Structure, items of uncertainty about the cost elements, the proposed development, production, and operating phase assumptions, and schedule. The analyst should ask: "what kinds of activities may have a range of possible outcomes?"

(1) The analyst needs to understand the components, their functions, and the interrelationships of the program under evaluation. The system needs to be described in terms that allow the risk analysis to be performed in accordance with the risk analysis objectives.

(2) The boundaries of the analysis should include minimum and maximum feasible conditions. The analyst should exercise care when evaluating each risk area and ensure that the analytical approach does not exceed the boundaries. If the result of the analysis appears to exceed the boundaries, the analyst needs to inform the other members of the team so an evaluation can be made.

(3) The determination of the boundaries is not solely the responsibility of the risk analyst. A multi-disciplinary team should work together to develop the boundaries.

(4) The analyst should be prepared to modify the items being evaluated during the conduct of the risk analysis.

(5) The selection of the items, boundaries, and underlying assumptions should be combined into a workable model. The combination of items should represent a feasible set of possible outcomes that reflect the internal and external program factors discussed below.

Break the program into its components at some specified level of detail. The risk analysis may not be conducted at the same level the program was estimated. Depending on how the estimate was prepared, there may not be a need to

analyze to the lowest level of the program structure. There may be some aggregation necessary for the risk analysis. The cost analysis plan should provide information concerning the level of detail.

Develop a list of risk areas. Determine an initial list of program elements that are potentially risky. There may be some program elements that have little or no risk associated with the value expressed in the estimate. These elements still are part of the total program cost, but their uncertainty may be slight or not existent. Additionally, the ICA Plan will contain some areas that are directed for risk analysis. Make a gross assessment of the trend in program cost and schedule for each risk area as it may develop. Estimate if and how each individual risk area may depend on the outcome of one or more other areas of the project and the extent of the dependency (complete, partial). The analyst should ask: "what is involved in the project that may not occur as estimated or planned in the baseline?" In determining the risk areas the analyst needs to consider external and internal factors that will form the environment for the program. Refer to Figure 2 for a summary.

(1) Analyzing external factors affecting the program normally requires information collected from expert sources knowledgeable about both the program structure and the external environment.

(2) In considering internal factors, the analyst needs to consider the differences in the program that make its future outcome differ from past programs. New technology, new designs, or different manufacturing processes will involve uncertainty and make the program different from previous similar programs. The analyst needs to estimate the impact of the changes and anticipated improvements. These estimates need to be translated into quantitative data for inclusion in the risk analysis model.

Review any other similar risk analyses. Review other risk analyses that may have been conducted for this or similar programs as applicable. In this step, determine if the methodology used for previous analyses needs to be modified for use in this analysis. The purpose of reviewing other risk analyses is to see if anything can be learned from the histories of other similar programs. The purpose of the risk analysis is to provide insight into the future. The analyst needs to insure that any trends or tendencies seen in other programs are free of unique occurrences or historical operations. The exclusion of the rare previous events from the trends will clear up the analysis of potential bias from events that probably will not happen in the future of this program. The analysis of previous histories requires knowledge and insight of the previous programs and an understanding of the current program.

PERFORM STAGE. The steps for performing the next phase of the risk assessment are as follows:

- Develop measurement standards,
- Collect available data for each identified risk area,
- Determine the range of possible outcomes for each item (develop a distribution),
- Conduct the initial modeling and calculations, and
- Identify risk items needing additional data or other processes or procedures required for completion of the assessment.

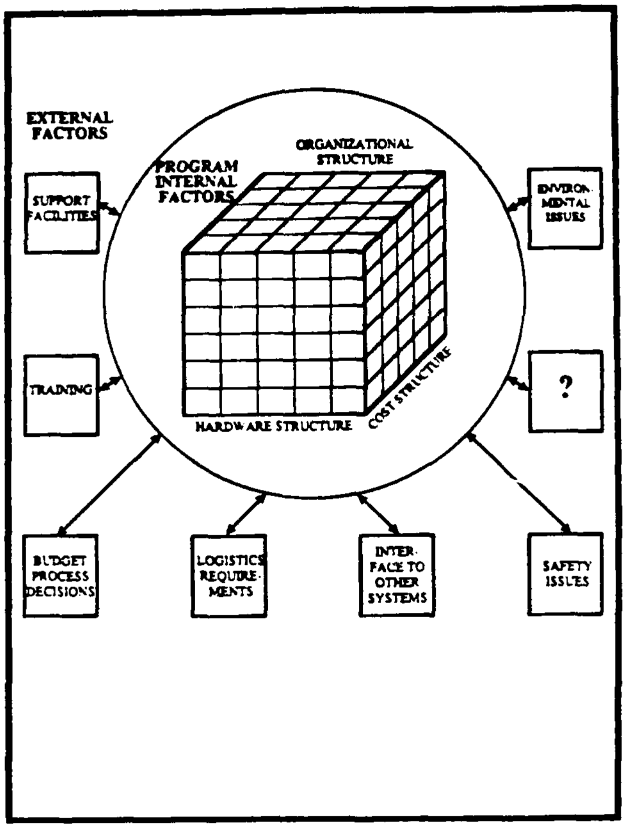


Figure 2. The Risk Analysis Needs to Consider External and Internal Program Factors

Develop measurement standards. In order to provide a basis for comparing and analyzing the risk assessment results, a set of measurement standards needs to be prepared in advance of the analysis. Measurement standards are also known as Measures of Effectiveness (MOE). These should be in terms of dollars, hours, pounds, feet/seconds, miles/hours, degrees, etc. All possible conditions in the program, their potential interactions, and their relevance to the study objective must be evaluated thoroughly.

(1) If the analyst is faced with many areas of risk in the analysis, a sensitivity analysis should be performed. The sensitivity analysis can provide insight into the relative weighting of each risk area on the overall program. Not all of the potential risk areas will be needed in the evaluation of the program's overall risk levels. Some areas of the program interact more significantly with other areas than do the remaining areas. These less significant areas may not be as sensitive to the overall level of risk to the program. However, without first identifying and ordering all potential risk areas, it would be impossible to distinguish precisely which potential risk areas needed to be included.

(2) Some of the risk areas can be controlled early in the life of the program. Some risk areas cannot be controlled until later in the life of the program. The criticality of risk areas can change during the program's life. The analyst should be aware of these potential changes.

Collect data for each identified risk area. This step is subject to the amount of time and data collection resources available. Additionally, the available data may not be in a form you can use, or it may not be applicable to the risk analysis activity at hand. It takes judgment and knowledge of the program to make informed decisions about the data and the effort required to collect and use it. Current or available models may be modified to permit use of the results of the risk assessment by determining what important assumptions and limitations must be imposed to provide a reasonable analysis. Determine the consequences of each possible risk area actually occurring in the project and formulate a feasible response that would lead to mitigating the risk area. Determine the response in terms of the common denominator: "is this a problem that time or money could help?"

(1) The analyst needs to collect

(1) The analyst needs to collect information on the entire setting of the risk area.

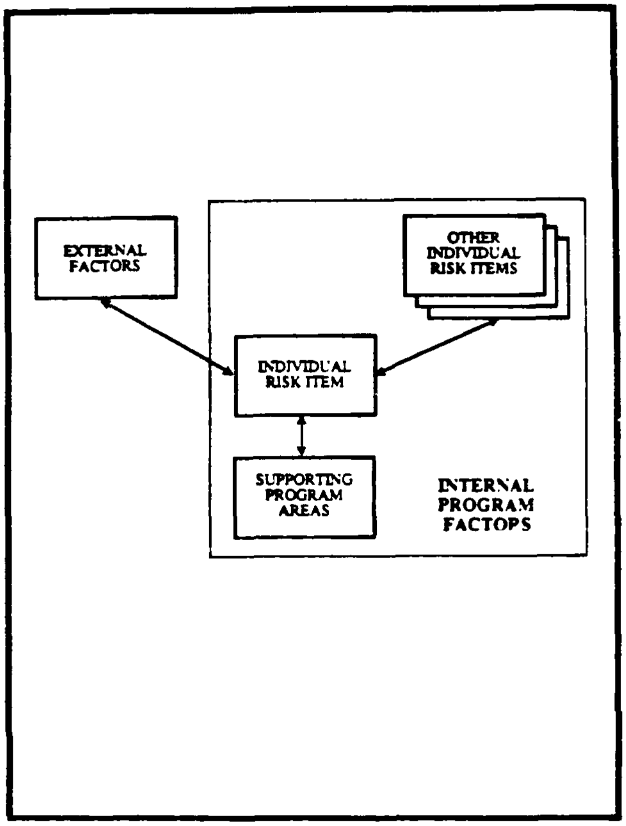


Figure 3. Consider All Interfaces When Collecting Risk Related Data

(2) The individual risk item is defined by the requirements, constraints, and interface characteristics under which the system will ultimately operate. This individual risk item affects and is affected by other individual risk items in the system. The individual risk items have in common certain related development or operational functions. The individual risk item also affects and is affected by the structure intended to support the item. In addition, the individual risk item is affected by external factors (e.g., availability of test facilities, etc.). The analyst needs to collect information on all these interfaces.

Determine the range of possible outcomes for each item. In this step the analyst will develop sufficient information to enable a description of the probability distributions for the selected elements. The analyst will need to consult with other members of the ICA team and possibly other experts for information on the range of possible costs for the elements, what would cause the costs to vary, and the likelihood that particular cost levels will occur. This step involves knowledge of the inter-workings of the program as well as of the individual items under study. Select a model or analysis technique that appears well-suited for the analysis task. Based on the information collected, you may select different approaches for different elements.

Conduct initial model computations and interpretation. Use the selected risk model or technique and the current inputs. Compute the probability distribution. Analyze the results for feasibility and rationality. Update the model and input data and reiterate the process as appropriate until the results are satisfactory.

(1) A risk analysis model is a logical, mathematical representation of the specific program areas and their interdependencies. It takes the form of mathematical equations. The model, when properly constructed, quantifies the range of possible outcomes and their associated probabilities for each item. The model should also provide the quantification of risk due to the individual items interacting to form the entire program. There is a great amount of interaction between the individual items under analysis. Constructing the risk model to portray this interaction requires the combined efforts of experts and other sources.

(2) All assumptions used in constructing the model need to be stated

clearly. They should be supported by factual evidence if possible. If no factual evidence is available, the underlying rationale for the use of the assumption should be known.

(3) The risk analysis model must cover the program adequately. Not every potential risk item needs to be included to represent the full spectrum of program risk. No model can perfectly nor completely duplicate the system. It is imperative that the analyst attempt to cover the entire spectrum of the program.

(4) The analyst cannot avoid modeling uncertainties facing the program. Technical or schedule risk may be difficult to collect and analyze, but they must be considered in the model. Modeling the program in this way can be ineffective. The probability of guessing correctly for every uncertain area is very small. The use of selected modeling approaches can reduce the effects of uncertain or ambiguous data.

(5) The construction of the model is directly affected by the type and amount of data collected. Data are needed to support the groundrules and assumptions, define the distributions, and the interfaces. Missing data items may prevent complete model utility. The analyst should consider the benefit of collecting additional data versus the cost.

(6) Validation of the model requires consideration of several aspects including the following items:

- Sensitivity: are the changes consistent with expectations?
- Suitability: does the model answer the right questions?
- Consistency: are the results consistent across the entire range of the distributions?
- Criticality: do minor changes in the groundrules and assumptions cause major changes in the results?
- Applicability: does the model require data or computational resources not currently available?

The analyst should consider the answers to questions such as these to determine areas of the model that may need modification.

Identify risk items needing additional data. This step comes from the careful analysis and use of the collected program data. While performing the risk analysis, the analyst may find it necessary to perform additional analyses or use a different approach for one or more items. The analyst should keep in mind all the available resources, models, tools, and other means of support so they can be used to conduct additional analyses as necessary. The analyst should ask questions like: "what could cause the estimated cost or schedule to change?" or "what could happen if these things occur?" to investigate possible cause and effect relationships for applicability to this situation.

PRESENT STAGE. The risk analysis is a management decision tool. Usually, the direct output of the conduct of a risk analysis is not in a form easily used or understood by management. The results of the model or technique could be a series of descriptive statistics or rows and columns of numbers. The decision makers may not be

sensitive to the message of the data in those forms. The analyst needs to reformat the data into a form useful to the decision maker so that the presentation of the results will increase the utility of the tool. To facilitate this presentation, the cost analysis process has specific documentation formats that are to be followed which convey necessary information in a manner useful to Air Force and other Government managers. After conducting the final computation, the documentation is finalized to accurately reflect the inputs, outputs, and analyses of the results.

CONCLUSIONS

A structured process for conducting a cost risk analysis has been presented. All that remains is to use one of the available models to aggregate and present the risk distributions.

BIBLIOGRAPHY

AFR 173-11, "Independent Cost Analysis Program" (Washington, DC, USGPO, 1986).

Atzinger, E., et. al., Compendium of Risk Analysis Techniques, (Aberdeen Proving Ground, U.S. Army DARCOM MSAA, 1972), DTIC AD-746 245.

Brown, R.V., A.S. Kahr, and C. Peterson, Decision Analysis for the Manager, (New York, Holt Rinehart and Winston, 1974).

Holloway, C.A., Decision Making Under Uncertainty: Models and Choices, (Englewood Cliffs, Prentice-Hall, 1979).

Hwang, J.D. and R.C. Banash, An Introduction to Decision Risk Analysis, (Rock Island, U.S. Army Armament Command, 1971).

McNichols, G., Cost-Risk Procedures for Weapon System Risk Analysis, IR-8016, (Falls Church, VA, Management Consulting & Research, Inc., 1980).

McNichols, G., et al, Air Force Risk Analysis Handbook, TR-9007/54-1R, (Falls Church, VA, Management Consulting & Research, Inc., 1993)

Moore, P.G. and H. Thomas, The Anatomy of Decisions, (New York, Penguin Books, 1976).

Raiffa, H., Decision Analysis: Introductory Lectures on Choices Under Uncertainty, (Reading, Addison Wesley, 1968).

Hitch, C.J., and R.N. McKean, The Economics of Defense in the Nuclear Age, (Cambridge, Harvard University Press, 1960).

Curran, Michael, "Range Estimating: Conquering the Cost Overrun," pp. 124-127, Proceedings of the International Society of Parametric Analysts, (Washington, DC, 1989).

THE PROCUREMENT KNOWLEDGE NETWORK: RECONFIGURED THROUGH EXPERIENCE

Dr. Diane R. Murphy
Procurement Automation Institute (PAI)

ABSTRACT

Electronic sources of procurement information are appearing everywhere: bulletin boards, CD-ROMs, on-line services, etc. However, there is still not widespread use of these services by the professionals who will benefit from these capabilities, the field contracting officers.

The paper looks at the impediments which exist to implementation of the Procurement Knowledge Network (PKN): an easy-to-use information system which will allow procurement information to flow freely from its source to every procurement professional who needs it.

The impediment is not the technology: information networks exist as illustrated by the government's increasing use of electronic mail (E-Mail) to communicate among its professional staff. Value added networks (VANs) have also created broad-based capabilities including bulletin boards and electronic data interchange (EDI). CD-ROM technology has advanced to the point that an information source can quickly and inexpensively master disks containing large amounts of data for distribution. Government organizations such as the Government Printing Office (GPO) have created electronic publishing for the Government facilities to use to meet their publishing needs.

The impediment is not the information source: virtually all Government agencies which create procurement information use automation to create that information. The various agencies make use of wordprocessing, desk top publishing, database management systems, and a variety of automated tools to manage vast amounts of information within their own office environments.

The impediment is not the potential user: most procurement offices are using, at a minimum, personal computers to perform such activities as order generation, solicitation and contract preparation, procurement tracking, and regulatory research. Many are also disseminating their information through bulletin boards and increasingly through EDI.

Problems, however, do still exist in the infrastructure to support government-wide procurement information exchange. Each procurement information source is specific to the organization which generated it and exchanging information between any two organizations is cumbersome. There is little appreciation among procurement professionals of the many government standards which support the movement of data between systems.

These standards do not necessary mean that all organizations which generate information must operate using the same computer platform or follow the same processes. Standards such as the Standardized Generalized Markup Language (SGML) impose a discipline for the transfer of information from one organization to another: interoperability.

Standards can also assist the implementation process by minimizing the number of access methods and search tools that individual users must use. Currently, procurement professionals in Government field offices must know where information exists; what telephone number to use to access the information; what communication protocol to use to communicate with the information source; and finally how to navigate around the information source to find the necessary data. *Many in the end, just don't bother: instead relying on the printed books in their offices or telephone calls to other contracting professionals.*

This paper examines the issues which must be addressed, today, if a Procurement Knowledge Network (PKN) is to be effective by the end of the 1990s.

The electronic revolution has begun, as witnessed by the number of electronic procurement information resources which have arisen over the past two years.

Considerable work still needs to be done to streamline, standardize, and reach the goals of equal and easy electronic access to all procurement information by every Government procurement official.

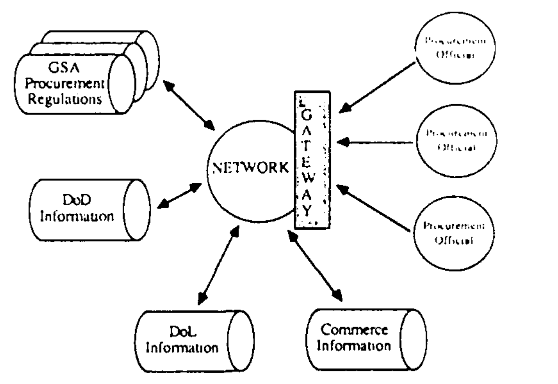
INTRODUCTION

The Government procurement process is time-consuming and complex. Individual contracting officers must comply with applicable Federal statutes, the Federal Acquisition Regulation (FAR), and department-wide, agency-wide, and often local implementations of these requirements. Individual agencies must also interact closely with other government agencies, such as the Small Business Administration (SBA) and the Department of Labor (DOL), to obtain the information necessary for any individual procurement.

Obtaining information is one of the major contributors to the slowness of the procurement process, and as such, the availability of electronic sources of information, readily available when needed, could significantly help streamline the government procurement process.

Electronic sources of procurement information (regulations, schedule information, etc.) are becoming readily available. Some are being distributed by the government, such as by the General Printing Office, others are available commercially from private sector publishers. To be effective, these information sources must be readily available to the contracting officer using a concept such as the Procurement Knwoledge Network (PKN). (Reference 1).

OVERVIEW OF PROCUREMENT INFORMATION NETWORK



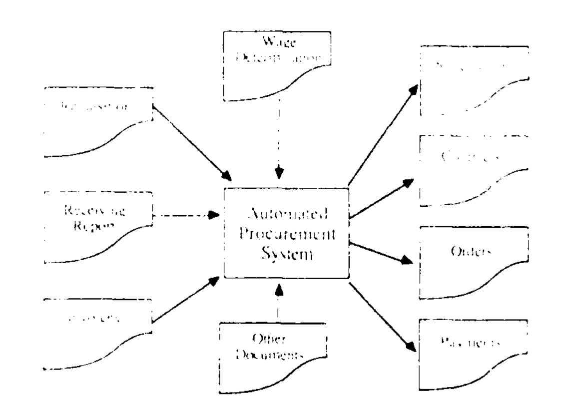
AUTOMATED PROCUREMENT SYSTEMS

Many procurement offices have automated their day-to-day activities. The typical procurement office has developed tools to support the paper-based Federal procurement process. These tools vary in complexity and also vary in the extent to which they improve the efficiency of the process.

Some agencies are merely using wordprocessing software on personal computers to generate Purchase Orders and Delivery Orders. Other agencies have implemented large-scale automated procurement management systems to meet their requirements for procurement tracking, small purchase processing, solicitation and contract preparation, vendor management, regulatory research, and Federal reporting requirements.

These systems are primarily designed to automate the processes within the Procurement Office, with paper being the main input to the system, and paper being the main output to the system.

TYPICAL AUTOMATED PROCUREMENT SYSTEM



There are no standards for automated procurement systems within the Federal government, neither is there a certification process as there is for government financial systems.

As such, there are many different implementations of automated procurement systems. These include the functions that are automated, the purpose of the system, the computer platform used, etc. Most contracting officers receive some training in internal automated systems and are becoming increasingly comfortable working in the specific environment of their office. Many frequently use E-Mail to communicate with others in their agency.

The major change in these automated procurement systems is the move towards integrated systems: systems which combine many functional capabilities into a seamless environment where information flows as the procurement progresses.

The biggest advantage of these systems is that data flows from one function to another, without the need for rekeying. For example, information such as a contract type or dollar value entered into the system to prepare an award document, can be automatically transferred to the Federal Procurement Data System (FPDS) for later FPDS reporting.

AGENCY-WIDE INTEGRATED FINANCIAL SYSTEMS

OMB Circular A-127, Financial Management Systems, has placed requirements on agencies to implement agency-wide integrated financial systems. (Reference 2). After payroll, the Procurement Office is usually the largest generator of financial transactions. As

such, the procurement system is seen as part of an agency's integrated financial system.

Integration can occur at two levels. The first level is when integration occurs by the electronic transfer of financial information from the procurement system to the financial system: this is usually referred to as interoperability.

The second level of integration occurs when the agency uses the same database or system for both the financial and procurement functions. This full integration becomes much more complicated since the operating organizations have to become integrated in their method of working. Also, fully integrated systems require more processing power and management attention than that needed by two separate systems

Most agencies are, therefore, implementing solutions which meet the needs of the OMB Circular A-127, yet maintain the separateness and functionality of the procurement and financial systems. The individual systems communicate with each other through a series of data transfers, agreed upon by procurement and finance.

ELECTRONIC REQUISITIONING

Another area where considerable progress has been made is in the area of electronic requisitioning: the use of automation to assist in the preparation of user requirements and the transmission of those requirements to the procurement office.

The primary value of electronic requisitioning is that it can reduce the lead time in the overall acquisition process.

The automated system can help the requisitioner prepare the procurement package, ensuring that is complete and accurate before it reaches the procurement office.

Many electronic requisitioning systems also allow requisitions to be routed electronically through such offices as program management, budget, information resource management (IRM), property, etc. Additional steps may also be implemented for special conditions (e.g., the use of hazardous materials).

In some agencies, electronic requisitioning is an extension of the procurement system. One example is the Department of Veterans Affairs (VA). An automated system termed IFCAP (Integrated Funds Distribution, Control Point Activity, Accounting, and Procurement) is used throughout the VA medical centers and other facilities. Almost all requisitions are received electronically in the procurement office.

In other agencies, the program offices have developed automated systems to assist in their budget and funds control processes. These organizations are putting pressure on procurement offices to accept their requisitions electronically. There seems little point to the user in printing the data from their electronic system, placing it on the standard agency requisition form, and then having the data re-entered as soon as it enters the procurement office.

The key, once again, to maximize the benefits to automation throughout an organization is interoperability:

agreement on a set of data items and their formats, such that data can be transferred from one system to another.

INFORMATION SOURCES

All procurement offices must adhere closely to Federal acquisition regulations and to agency-specific implementation of these regulations. The procurement process is complex, however, requiring access to procurement-specific knowledge that is constantaly changing.

This information includes the regulatory framework for procurement as established in the FAR and its applicable supplements; availability of small or disadvantaged businesses that can provide a particular commodity; availability of information from Government mandatory sources such as the Federal Prison Industries (FPI) or the Committees for Purchase from the Blind and Other Severely Handicapped; availability of a particular commodity through the GSA Federal Supply schedules; a Wage Determination from the Department of Labor; or date of publication of a synopsis is the Commerce Business Daily, to name a few.

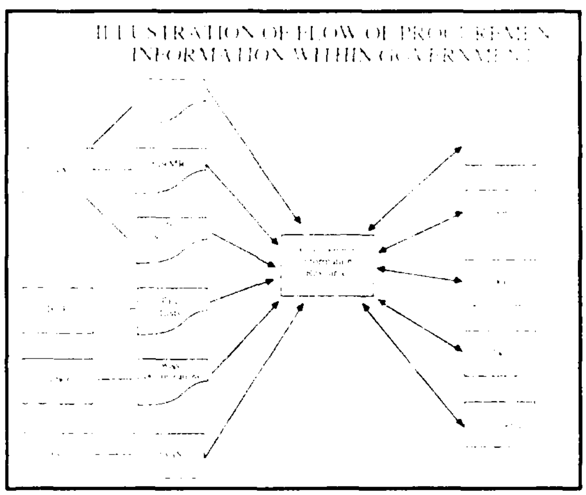
These information sources are becoming available in electronic forms. A small number are distributed directly from the organizations responsible for the creation and maintenance of the information.

However, most of the automated tools available are through private companies, who have "reautomated" the information generated by the Government.

One such example, is the Source One product available on CD-ROM through Information Handling Services (IHS). This product includes the products available from the Federal Prison Industries (FPI), the Committee for Purchase from the Blind and Other Severely Handicapped, and several hundred firms who hold Federal Supply Schedules. This product has been available for some time, originally beginning as a microfilm collection.

Other examples include the text of the procurement regulations themselves: some ten companies regularly scan, rekey, or process printer's tapes of the regulations, and provide search products on CD-ROM or on disk. One such product is Taurus, a CD-ROM product produced by Government Counselling, Inc. which contains the text of the procurement regulations (FAR, FIRMR, DFARS, etc.) packaged with other relevant materials for the ADP community including protest decisions and GSA/IRMS publications.

Both of these examples illustrate the need for the procurement professional to access information which is derived from a number of government sources. This is illustrated below:



Over the past two years there has been some recognition on the part of the Federal government agencies that their responsibilities go beyond creating the information: they are also responsible for distributing it to their users. This responsibility includes distribution through electronic publishing. The most significant of these electronic publishing initiatives has been made by GSA. They have been issuing a CD-ROM version of the FAR, FIRMR, and related publications for the past few years. The product is distributed quarterly through GPO, and is available for an annual subscription of around $120, making it a viable alternative for any Government agency or contractor.

CD-ROM products containing procurement information are becoming common-place. This is in part due to the acceptance of the technology; most procurement offices now having access to a CD-ROM reader.

Another consideration is the cost of "mastering" a CD-ROM, i.e., producing the first disk for duplication. These cost have reduced dramatically over the last three years. It is now possible to acquire equipment that will master a CD-ROM in your own office for less than $10,000. This equipment called CD-R (CD Recordable) is ideal for prototyping new offerings which will later be produced in large numbers conventionally or for the final distribution of disks which have a limited distribution.

This ability to quickly and cheaply create CD-ROMs will assist Federal agencies to develop procurement information sources which are specific to their own environment (e.g., contain Federal regulations as well as department-wide regulations, internal policy directives, etc.), for a relatively small user population.

USING ELECTRONIC INFORMATION SOURCES

The electronic sources of procurement information which are available today are beginning to have a broad base of users. The sheer volume of information that can be held on a CD-ROM (equivalent to 200 Websters dictionaries) and the ability to search this information electronically is significant.

Three issues, however, still remain. The first of these relates to the information needs of individual organizations. Although there is a vast amount of procurement information pertaining to the Federal government as a whole, each contracting officer (user) needs a unique subset of this information. This subset may include the acquisition regulations that apply to the user's organization or the information sources that relate only to the specific commodity that is being acquired (e.g., ADP). At present, this information is embedded in several information sources across several CD-ROMs, often by different publishers.

The second area of concern is the many different search tools which must be learned to use the various CD-ROM products. Different publishers (Government and private) have used different search software and have organized the data to be searched in different ways. While some search systems have easy-to-use help functions, it is still frustrating for users to move from one CD-ROM to another.

The final area of concern is the currency of the CD-ROM disks. Many are updated

quarterly (e.g., GSA's CD-ROM of the FAR/FIRMR); monthly (e.g., IHS's Source One) or weekly (e.g., Counterpoint's Federal Register). These updates usually are not frequent enough to ensure the data on the CD-ROM is current, particularly given the lag time to master and distribute the CD-ROM.

Alternate information sources must, therefore, be used to obtain the most current information.

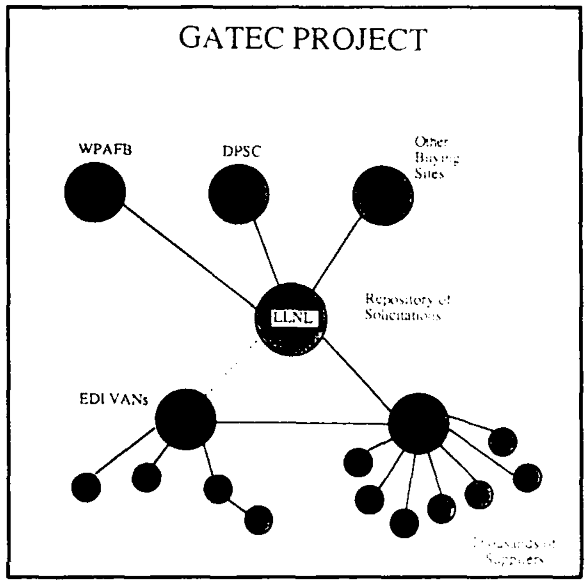
BULLETIN BOARDS

Perhaps, the most explosive growth in the availability of electronic procurement information is the use of bulletin boards.

An electronic bulletin board is a central system that provides dial-up access to users through electronic communication. There are two main uses of procurement-related bulletin boards. The most prevalent use is the electronic bid board which allows users to identify solicitations as they are issued. Some bid boards also allow firms to submit their bids electronically. Traditionally these bid boards are used to publicize contracting opportunities under small purchase procedures.

One of the first bulletin boards for small government procurement was established by the Naval Supply Center in Jacksonville, FL in 1989. The system allows subscribers to view and quote on small purchase requirements. The system is called EASE (Electronic Assisted Solicitation Exchange) and has been extended to other Naval Supply Centers.

Also of significance is GATEC (Government Acquisition through Electronic Commerce), a pilot project at the Department of Air Force, Wright-Patterson Air Force Base. GATEC is intended to be a DOD-wide procurement bulletin board, with a single organization (currently Laurence Livermore National Laboratory (LLNL)) acting as a repository of solicitations.



Solicitations are posted from a variety of sites including Wright-Patterson Air Force Base and the Defense Personnel Supply Center in Philadelphia. Initial capabilities include providing RFQs and receiving quotes electronically. Access to GATEC is through a series of some 17 VANs, each of which must be certified.

A number of government organizations are also beginning to use bulletin boards for larger contracting opportunities. Since the FAR mandates that actions over $25,000 are published in the Commerce Business Daily, these organizations typically advertise the requirement with a notice such as:

> "Interested vendors may access the bulletin board to retrieve the solicitation."

Organizations with recent notices in the CBD include U.S. Army Information Systems, Defense Commercial Communications Office (DECCO), and SPAWARS.

The second use of procurement-related bulletin boards is to provide access to information sources where data is constantly being updated.

For example, GSA has developed bulletin boards to disseminate changes to the FAR in both proposed and final form shortly after the Federal Acquisition Circulars and Proposed Rules are published in the Federal Register. Changes are presented both in context as well as in revised subsections, sections, and clauses. These FAR bulletin boards are accessible through normal E-MAIL procedures as part of the FTS2000 telecommunication services offered by AT&T and Sprint.

A second information source which is available through a bulletin board is the List of Parties Excluded from Federal Procurement or Non-procurement Programs, formerly the List of Debarred and Suspended Bidders.

Another GSA innovation is the Multi-Use File for Interagency News (MUFFIN) Gateway which allows Federal agencies to review electronic catalogs and create simplified purchase order using model, part, and descriptive information from the catalog.

Once again, the availability of these bulletin boards is not without its problems. There are currently no standards covering when and how a government agency establishes a bulletin board.

Many agencies have chosen the lowest cost solution: a small microcomputer, with a single modem, and commercially available bulletin board software (BBS), operating at their office location. Other procurement offices have selected to place their procurement-related information on general agency or command-wide services. Finally, most VANs provide bulletin board services.

The result is a proliferation of bulletin boards. To make use of them, the user must first know that they exist, obtain the telephone number and any telecommunications protocols, and then dial-in (after long distance). Once on the bulletin board, the user is faced with many different menus and search functions.

ELECTRONIC DISSEMINATION

Electronic sources of information are not only a problem for the user: dissemination of information through CD-ROMs or electronic bulletin boards can also pose problems for the information source.

Many of the processes which generate the procurement information to be the subject of the dissemination process are themselves automated. Most, however, use some form of in-house or proprietary wordprocessing or desktop publishing software. For example, a MacIntosh desktop publishing environment is used by GSA in the FAR publication process.

These systems usually use proprietary formats to denote the special formatting characteristics of a piece of text (e.g., bold, underline, tabs). This information is

generally lost when the information is transferred to the systems which create the CD-ROM or load the bulletin boards. The standard method for transferring such information is the ASCII file which does not support such proprietary coding schemes.

Transfering complex information from one environment to another can be costly and time consuming, if the same quality document is to be produced electronically that is available in hard-copy. Many information sources do not know how to do this efficiently.

STANDARD GENERALIZED MARKUP LANGUAGE (SGML)

Standards do exist to facilitate the transfer of text from one publication system to another, the most significant of these being the use of the Standardized Generalized Markup Language (SGML). SGML is a widely used methodology to standardize the way publication-quality text is represented that permits interchange between different wordprocessing or publishing systems. (Reference 3).

SGML uses an alternate approach to the procedural markup used in conventional wordprocessing systems. A word or phrase to be emphasized as a certain "type" (e.g., title) but not to specify the type of emphasis to be made (e.g., boldface italics). This is called "descriptive markup", and has some clear advantages.

If information is marked as "title" rather than a sequence of words marked as "boldface italics", it can be easily distinguished from the rest of the document, and can be converted to "boldface italics" when printed in another system.

Descriptive markup can be made to be independent of a particular product, and can be designed to be "read" by computerized systems and by humans. In this way, all the information can be readily interchanged not just the text itself.

An example of a tagged document is shown below:

EXAMPLE OF TAGGED DOCUMENT BEING PARSED

When parsing this document

```
<!DOCTYPE FAR SYSTEM "C:\MYDIR\FAR.DTD">
<Book>
<P>Finally illustrations and mathematical formulae
may by added to SGML documents.</P>
<XMP>Test your understanding
<P>Try to answer the following questions to check
whether you understood the material presented in this
chapter.</P>
</XMP>
</Book>
```

you obtain this error message:

Error in tag close at '>'
XMP end tag ignored: doesn't end any open element (current is Book)

For the example above, a format error has been found.

SGML is an established standard for descriptive markup. It is a set of rules for descriptive markup and provides for:

- Defining the structure of documents and the logical units of which it is composed; and

- Tagging individual fields with text such that they may be later processed (e.g., in print preparation or for data extraction purposes).

Another advantage of SGML is that it can be used to ensure that text provided in a prescribed format contains certain types of data or is in a particular sequence.

ELECTRONIC DATA INTERCHANGE (EDI)

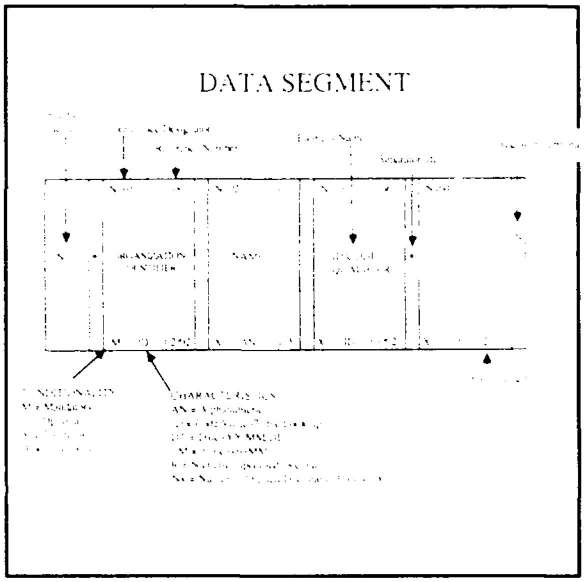
Electronic Data Interchange (EDI) is the computer-to-computer exchange of routine business information in a publicly accepted standardized format. For EDI to work, the sender and receiver of the business information must communicate in the same format.

The computer-to-computer interchange of information is not new. Since the mid-1950s, large private companies have been communicating business information electronically. But, because users communicated in unique formats, businesses found it cumbersome and time consuming to expand their electronic communications to new trading partners.

Today, however, nationally and internationally recognized data formats have been developed, commonly referred to as standards or transaction sets that allow easy interchange of data.

The Transportation Data Coordinating Committee (TDCC), formed in the late 1960s, initially created EDI standards for rail, motor, air, and ocean shipping. Its success at developing these standards, led other industry groups such as grocery, chemical, and warehousing to seek its help. As TDCC created industry-oriented standards, some companies that used them saw the need for generic standards that cut across industry boundaries.

In 1979, the American National Standards Institute (ANSI) formed the Accredited Standards Committee (ASC) X12 to develop uniform standards for electronically interchanging business transactions between and among industries. The ASC X12 publishes a common data dictionary that provides common EDI transactions. Below is an example of an ANSI X12 data segment definition. (Reference 4).



As the Federal government moves towards electronic commerce, the use of these EDI standards will become significant. (Reference 5).

CONCLUSIONS

More and more information sources are available in electronic form: the principle mechanisms being CD-ROM electronic publishing and bulletin boards.

Individual organizations have often introduced these products to fulfill specific information needs. The products generally work well when used individually.

However, a contracting officer needs access to many, or at least parts of many, information sources. Searching across multiple CD-ROM sources, or accessing multiple bulletin boards is a time consuming and frustrating process requiring high levels of computer awareness.

If the Procurement Knowledge Network (PKN) is to work, it must be easier for information source generators to publish their materials and easier for the field contracting officer to use them.

This transition will be best accomplished through the adoption of existing standards, such as SGML or ANSI X12.

REFERENCES

1. Murphy, D.R. Imagining, Innovating and Implementing the Procurement Knowledge Network, 1991 Acquisition Research Symposium Proceedings, National Contract Management Association.

2. Office of Management and Budget: OMB Circular A-127, Financial Management Systems.

3. Van Herwijnen, E., SGML Tutorial, Graphics Communications Association.

4. DISA, 1993 DISA Publications Catalog, Incorporating Introduction to EDI, Data Interchange Standards Association, Inc.

5. Drake, DJ; Ciucci, JA; and Milbrandt, B., Electronic Data Interchange in Procurement, Logistics Management Institute, 1990.

PROTECTING THE U.S. TECHNICAL LEAD

CPT Robert A. Newton, OASD(C3I)

ABSTRACT

Several Department of Defense studies have indicated that acquisition programs, which were designed to achieve a combat effective lifetime of 10 to 15 years, were often achieving less than a third of this lifetime. In fact, 50 percent of the evaluated acquisition programs had countermeasures deployed against them within three years of Initial Operational Capability. The reason for this condition was the compromise or inadvertent loss of information to foreign intelligence services.

Due to the conditions discovered by these studies, the Under Secretary of Defense (Acquisition) established the Acquisition Systems Protection Program (ASPP) in 1991. The ASPP concept required program managers and the acquisition community to integrate security planning and counterintelligence operations directly into the acquisition and engineering design process.

However, the goal is not to protect the entire system. Rather, the ASPP concept mandates the identification of the system' s most essential elements for protection. As a result, the goal is to increase the protection provided to these key components, while reducing the overall cost and administrative burden of protecting the system from compromise.

Introduction

Although the direct military threat from the former Soviet Union no longer exists, the United States still faces a major threat to its national security. This threat is much more subtle and diverse than the overt military threat. In this case, the threat is the effort by the states of the former Soviet Union, as well as other nations, to acquire and produce key technologies developed in the United States for military or economic advantages. This threat is every bit as grave as the overt military threat from the Soviet Union used to be to the nations's security. In an era of multinational corporations, joint development programs, and military grants, the loss of key defense technology is likely to increase unless positive steps are taken to stem the unauthorized flow of information.

Presently, the Department of Defense spends about eleven billion dollars a year on research and development programs. However, unless we can ensure these programs are not compromised, this investment will be wasted. The purpose of this research effort is to ensure our soldiers are the best equipped and most confident soldiers on the battlefield. However, if our weapons are compromised; their technology copied or countered by the enemy or a third party, then our soldiers will not have this advantage during the battle. The end result will be a significantly higher casualty rate for our forces than our commanders should have expected.

Background

Although spies and espionage

have existed for many centuries, the efforts and techniques employed by modern intelligence services supplement these techniques with sophisticated electronic collection systems. However, the greatest threat to most acquisition programs is still the human agent. In this country, the spy's mission is aided immensely by our open society. Many research programs, which would be classified or compartmentalized in other nations, are openly discussed in professional journals and other public forums in the United States.

Although the United States had an effective system to counter most intelligence operations of traditional adversaries during the Cold War, this system will face a new, diversified threat in the future. In addition to the vast intelligence collection resources of the Russian state, many of the Republics are creating their own intelligence services. Further, the demise of the Soviet Union has allowed other governments to divert intelligence assets to the collection of technical information from us. As the world enters the new, multi-polar era, the threat of industrial and economic spying is likely to increase dramatically. This trend has forced the United States to focus new attention on the security of its research and development efforts.

Two major studies clarified the magnitude of the threat to Defense acquisition programs. One study was conducted under the direction of Congress, while the other study was directed by the Under Secretary Of Defense (Acquisition). The latter study was known as the **Protection of the U.S. Technical Lead (PTL)**.

Of the unclassified findings, the most significant ones concerned the management of security programs within the acquisition community. The first finding noted that the only document which addressed security issues in most collateral programs was the Security Classification Guide. However, the finding also noted that the guide rarely contained any information or guidance on the scope nor intent of the protection effort. As a result, most programs lacked a coherent, integrated plan to protect the technology produced within the program.

Similarly, another finding noted that DoD lacked central direction for protection planning and oversight. This condition was reflected in program offices and range facilities, where commanders rarely allocated security programs sufficient resources or personnel to implement an effective protection program. Compounded by a lack of security training for personnel in the acquisition community, these findings underlined the need for a "cultural" change to integrate protection planning into the protection process.

This need was manifested in the study's recommendations. The most significant recommendation was to have USD(A) assign the responsibility for protection planning to the program managers. Further, the study recommended that DoD allocate the counterintelligence and security specialists to the program offices to help the program managers develop an effective protection strategy. In addition, the study recommended an integration of protection planning into the curriculum of acquisition training programs. Also, the study recommended the establishment of a DoD-level office to

act as the focal point for protection efforts and to develop a Master Plan to address infrastructure issues.

The Congressional study was the result of the FY 91 and FY 92 budget hearings. After a review of selected range facilities and selected acquisition programs, several members of Congress became extremely concerned about the security of Defense acquisition programs. In turn, this concern resulted in several recommendations from Congress to the Secretary of Defense. Many of the recommendations were similar to the conclusions of the PTL group. In addition, Congress recommended that DoD to establish oversight responsibility for protection planning and document the cost of protection measures. Further, Congress recommended that DoD develop a strategy to fix the security deficiencies at the range and support facilities.

These findings led to several changes within DoD. One of the most significant changes was the establishment of the Acquisition Systems Protection Office (ASPO) within the Office of the Secretary of Defense. The ASPO was tasked by the Under Secretary of Defense (Acquisition) to (1) review the security classification guide and program protection measures of all major acquisition programs, and (2) provide a written assessment of these documents to the Defense Acquisition Board Committee prior to each Milestone Review. When one considers the number of minor acquisition and research programs which feed the major programs, this review authority is more encompassing than it may appear.

In addition, the ASPO was tasked to develop a plan to address the security infrastructure problem at DoD facilities, as well as develop a plan to ensure the uniformity of protection efforts for technology or information which is used within multiple programs.

The other major change was the incorporation of protection planning requirements within the DoD directives and instructions which govern acquisition management. In Part 5, Section F of DoD Instruction 5000.2, program managers are told:

> "a comprehensive protection and technology control plan shall be established for <u>each</u> defense acquisition program to identify and protect classified and other sensitive information."

Further, this same section states this plan will address:

- the use of counterintelligence and operation security surveys to monitor information loss during system development;
- the definition of threat options (reactive threat) and the potential for exercising those options which could counter the acquired systems capabilities;
- the potential vulnerabilities of the acquired system due to evolving threat capabilities; and
- for international programs, technology assessment and control will be addressed.

With these initiatives, DoD has taken action to address the concerns

expressed in these studies. However, the Department faced the equally tough task of bringing the 1000(+) acquisition programs into compliance with these guidelines. The primary method DoD has elected to use to fulfill its oversight responsibility is through the review of each system's or component's Program Protection Plan as part of the Defense Acquisition Board review process.

THE PPP

Since the development of a program protection plan is a requirement for all acquisition programs, acquisition personnel must be familiar with the goal and objectives of the plan. The ideal plan is one which blends elements of counterintelligence analysis, operations security, traditional security disciplines, and system security engineering to provide an efficient and cost-effective strategy which will protect the system from all collection threats during development and deployment. To ensure the protection plan is fully integrated into the program's operations, DoD Instruction 5000.2, Part 5, Section F directs program managers to:

- develop a protection plan prior to the Milestone I Review and update it prior to each subsequent review;
- produce a protection plan that will include program related activities at test centers, ranges, laboratories, contractor facilities, and deployment locations to provide protective measures for all phases and aspects of the acquisition process.

Presently, DoD is using an assessment of the Program Protection Plans of all major acquisition programs (and their component systems) to measure the degree of compliance. The ASPO has been directed to provide a written report to the DAB Committee on the effectiveness of the plan prior to each review. When programs are found to be deficient, the DAB Committees have directed the programs to revise their plans and resubmit them at a later date.

With this degree of emphasis on the PPP in the DAB review process, one may wonder what criteria the ASPO will use to review the PPPs. The Program Protection Plan should accomplish two goals for the program. First, it should serve as a unified, integrated strategy for protecting the key technologies and information of the system during all phases of development. Second, the plan must clearly and concisely identify the system's Essential Information, Technologies, or Systems (EPITS) for protection and formally commit to a strategy to ensure their protection from compromise or unauthorized disclosure.

The ASPO evaluates the protection plans based upon a series of exit criteria. The first element of the plan which comes under scrutiny is the system description and program description. The system description must clearly describe the mission, military value, and operational parameters, as well as identifying any supported or supporting programs. The program description should discuss the organization of the program office and identify the locations of any facilities where essential program elements will be stored, tested, analyzed, or produced.

Perhaps the most critical element of the review is the analysis of the system's Essential Program Information, Technologies, and Systems (EPITS). The EPITS are those elements of the program which, if compromised, would cause a reduction in combat effectiveness or reduce the combat effective lifetime. The EPITS are those elements which give the system its unique ability on the battlefield. The identification of the EPITS in the protection plan plays the same role as the commander's intent in an operations order; they focus the protection efforts and clearly delineate what elements must be protected to ensure mission accomplishment. By providing this focus,the acquisition community should be able to reduce the costs of protection while increasing the level of security provided to the program.

To properly identify the EPITS, the program manager must "decompose" the system. In effect, the program manager needs to identify the specific component or system which allow the weapon to accomplish each of its assigned functions on the battlefield. Subsequently, the program manager determines if the identified element is an EPITS by answering four questions:

If a foreign intelligence service obtain this information or item,

- could they devise a method to <u>kill</u> my system?
- could they devise a method to <u>clone</u> my system?
- could they devise a method to <u>neutralize</u> my system?
- would I have to change the design to ensure the same level of superiority on the battlefield?

If the answer to any of these questions is "Yes",the item would qualify as a possible EPITS. Closely related to these questions is the requirement to define the loss criteria. The program manager must determine if the mere possession of the item, knowledge about its abilities, or the ability to reproduce the item constitutes loss. This definition will play a critical role in the evaluation of the collection threat to the program.

Once the initial screening of the EPITS has been accomplished, a refinement process needs to occur. Specific components or pieces of high technology should be consolidated under common sub-systems. These specific elements are known as Sub-systems or Technologies (SOTs). In addition, the program officials should attempt to define the elements as closely as possible to recognized, DoD terms based upon lists such as the DoD Key Technologies List or the National Disclosure Policy categories. This consolidation and refinement will assist the intelligence analyst identify the collection threat to the system.

One of the major tasks for the protection plan is its role as a counterintelligence document. By tasking the intelligence community to provide the information, the program manager identifies the existing and anticipated intelligence collection threat to the program. The program manager should task the intelligence community to identify (1) which countries have an interest in the system's EPITS, (2) what level of research those countries are

conducting in these areas, and (3) what capability those countries have to collect information on the EPITS. When the answers to these questions are matched to the locations where EPITS-related information exists, the identification of the program's vulnerabilities becomes possible.

Once the vulnerabilities are identified, the countermeasures program can be designed. Countermeasures should only be implemented if a vulnerability exists, due to regulatory requirements, or due to the use of classified or sensitive EPITS material from another program. If one of these conditions does not exist, the program manager should not waste limited resources protecting the system from a threat which does not exist. However, the program manager must realize that the threat environment *is dynamic and* new conditions may develop which will require a change of the protection concept to protect the system's EPITS.

Once the vulnerabilities and other protection requirements are identified, the program manager should place them in a priority sequence based upon their impact to the program if compromised. Subsequently, an informal, cost-benefit analysis should be performed to determine which elements can be protected with the available resources. Ideally, all vulnerabilities concerning EPITS should be countered. Once this data is compiled, the countermeasures and cost data should be included in the protection plan.

Three enclosures supplement the protection plan. The time or event-phased, Security Classification Guide provides guidance to all users or producers of the system on the level of protection which should be supplied to various components. As such, it should be oriented upon the system's EPITS. The Guide should not only specify the classification level of material, but it should indicate which material should be protectively marked or limited in distribution in accordance with DoD 5200.1R. Also, the Guide should contain specific criteria for the reduction of classification requirements or the termination of protective restrictions.

The Technology Assessment / Control Plan is used to assess the risks and benefits of joint development programs with foreign countries or foreign military sales. In addition, if such arrangements are approved, the plan provides the specific guidance required to protect essential U.S. technology from *compromise*

The System Security Annex addresses the security threats and vulnerabilities of the system in the <u>operational</u> environment. The annex is an engineering plan which discusses how the system's design will be modified to reduce security costs and burdens upon the user after deployment. In addition, this annex will discuss how the existing design could be modified to allow the sale or production of the system abroad.

The complete Program Protection Plan (with annexes) provides a complete, integrated program which protects the system from the establishment of Mission Need until the system is retired from service. The Program Protection Plan is the only plan in the acquisition process which addresses security issues. As such, it is an extremely valuable document for the acquisition community,

the users, support facility commanders, and oversight officials.

Why Should I Care?

Many individuals within the acquisition and intelligence communities question the need for these changes by DoD. Several individuals view this requirement as nothing more than another "hurdle" which program managers must "jump" over. These views are wrong! The Acquisition Systems Protection Program is a direct result of recognized problems associated with the protection of weapons programs and key technologies from compromise or loss. Failure to protect the system from compromise can only lead to increased battlefield casualties should U.S forces have to use the system in combat.

Another complaint is this new concept is not any different from the system of regulations and directives which already existed. Once again, this view is not in focus. Although the concept relies upon many of the same regulations and policies which existed in the past for guidance, the true difference is the scope and range of the ASP program. The ASP concept requires the program managers to identify the most essential elements of the program for protection, not the entire system. Once these elements are identified, the manager must task the intelligence community to identify which foreign intelligence services have the interest and capability to collect the information instead of relying on a "worst-case" scenario. If a threat or vulnerability does not exist, countermeasures do not have to be developed. The countermeasures program must provide specific guidance on the protection strategy to all personnel who have EPITS information within their possession. As a result, we are shifting the emphasis of protection efforts from "regulatory compliance" into an era where the program manager is required to outline a specific protection strategy and providing the needed direction to counter known or anticipated threats to the system. This focus allows DoD to reduce significantly the amount of material which must be classified, while concentrating the protection efforts on the most important elements of the program.

Another common misconception is that the ASP program will increase program costs. The most common reason for this belief is that the ASP program is just a new version of Special Access Programs (SAP). Unlike SAPs, the ASP concept does not orient on protecting *everything* (including the program's name) from compromise or loss. The goal of ASP is to protect the 10-15% of the program which gives the system its unique combat capability. As a result, protection of these key elements can be significantly increased while maintaining or reducing the cost of protection.

Conclusion

The Acquisition Systems Protection Program is a major effort by DoD to protect the technical advantage that American soldiers have traditionally enjoyed on the battlefield. Unless U.S. technology is protected and weapons are not compromised, the likelihood of increased battlefield casualties is significant. The ASP concept is designed to increase the protection provided to the most essential elements of Defense research while reducing the cost and administrative burden of protection

CPT Newton is assigned to the Office Of the Assistant Secretary of Defense (Command, Control, Communication and Intelligence). He is an acquisition officer who earned his undergraduate degree in 1981 from the U.S. Military Academy and his Master's degree from the University of Virginia. He has served with tactical units in Korea and at Fort Hood and he has served as an Assistant Professor at the U.S. Military Academy. Upon the completion of his tour at OSD, he will proceed to the Command And General Staff College.

Bibliography

1. "Protecting the U.S. Technical Lead: A Review of Information Security and the Use of Threat Assessment in Systems Acquisition (U), " report of the Review Group on Protecting the Technical Lead (U), USD(A), June 1, 1990, (classified SECRET).

2. Senate Report 101-358.

3. House Appropriations Committee Report 101-822.

4. House Armed Services Committee Report 101-665.

5. Department of Defense Directive 5000.1, "Defense Acquisition."

6. Department of Defense Instruction 5000.2, "Defense Acquisition Management: Policies and Procedures."

7. "Protecting the U.S. Technical Lead in Systems Acquisition," memoranda from the Acting Under Secretary of Defense (Acquisition), January 10, 1991.

8. "Acquisition Systems Protection Master Plan," memoranda from the Under Secretary of Defense (Acquisition), May 12, 1992.

9. "Defense Acquisition," memoranda from the Under Secretary of Defense (Acquisition), May 20, 1992.

10. Memorandum of Agreement on the Joint-Service Acquisition Systems Protection Program (JASPP) signed by the Assistant Secretary of the Air Force (Acquisition), the Assistant Secretary of the Army (Research, Development, and Acquisition), and the Assistant Secretary of the Navy (Research, Development, and Acquisition), July-August, 1990.

11. National Military Strategy, Department of Defense, 1992.

12. Proceedings of the DoD Acquisition Systems Protection Workshop, April 7-9, 1992, Volume II, "Program Protection Documents," Institute for Defense Analyses, Alexandria, Virginia, 22311-1772.

THE USERS' STAKE

IN THE AUTOMATION OF GOVERNMENT CONTRACT OFFICES

Lawrence H. Oppenheimer, ***Price Waterhouse***

ABSTRACT

In the last few years, federal contracts offices have begun to automate their financial and administrative functions. These efforts have focused either on specific functions within the offices, or on the entire operations of the office. As government managers examine alternative approaches toward automation, and alternative office processes after automation, contracts professionals within the organizations should recognize that they have a lot at stake.

The objectives of automation, and how automation is implemented, is critically important to the people within a contracts office. Although more automation is inevitable, the record of successes to date has not been uniform. The purpose of this paper is to identify issues in automation, how different approaches can have unanticipated effects on the professionals in the offices, and how management and the users can maximize some of the positive (and avoid some of the negative) effects from automation.

INTRODUCTION

This paper is intended to be a "consumer's guide" to automation of Federal Government contracts offices. Although the focus is only on the contracting operations, some of the principles can be applied to other functional office environments. In fact, most of the principles were originally developed through automation of other types of operations.

The paper's provides a very brief description of the automated tools that are currently being implemented, and the benefits/objectives of management's investment in automation. Then the paper describes the prospective effects of automation on office performance, office work patterns, and the people working in the office.

The paper's focus is on the changes that the current contracts professionals are likely to experience, and the actions that people can take to improve the likelihood that automation will improve office performance, the office environment, and professional opportunities.

A few last notes: This paper is concerned with offices that do "Contracting" versus "Purchasing", - meaning that Contracting offices are those that do procurements over $25,000. Automation of purchasing offices is importantly different from that of contracting offices, and is at this point more advanced.

Second, by automation, we do not mean word-processing, or use of shrink-wrapped

or in-house-developed applications on commercial software. Instead, we mean the use of specially-developed and customized commercial tools for contract operations. Also, the emphasis is on the effects on career contracts professionals, not on either technical ADP people or on temporarily attached people.

1. What Automated Tools are now Available for the Federal Contract Environment?

In recent years, a large number of new software tools have been specially developed for federal contract operations. The new tools include comprehensive systems designed to meet and integrate most of the requirements of a Contracts Office, and also specific special purpose contracts tools. These new systems and tools generally perform much better than the systems that were introduced five to ten years ago, and are starting to win acceptance among users.

For the most part, these new tools are designed to take advantage of the faster and more-powerful micro-processors now available (386 and 486), use the newer operating systems (UNIX and Windows), and are written in modern languages (such as the relational database management systems).

Some contracts offices, particularly in the DoD, have installed and implemented various flavors of sophisticated and comprehensive contract management systems. Many offices, both in DoD and outside of DoD, have purchased special-purpose tools to improve the operations of certain office functions. These tools include:

- Management Aids and Tracking Tools
- Form Generators
- Data Retrieval Tools
  (FAR, DFARS, FIRMR, etc.)
  (Vendor Information)
- Document Assembly Tools
  (Solicitations, Contracts, SOWs)
- Automatic Agreement Generators
- Communications (EDI, etc.)
- Financial and Contract Accounting
- Asset and Property Tracking

The purpose of this paper is not to analyze or evaluate the specific tools or systems, but instead to show that the work of the professionals in the contracts offices is affected by the success or failure of automation, and that those professionals can learn from the experience of others and can take measures to enable automation to achieve its objectives.

2. Objectives of Automation

In many cases, management's primary objectives of automation are to reduce costs, and/or to improve efficiency. They intend, through implementation of a system or a tool, to reduce the labor involved in various contract functions.

From the view of existing employees of a contracts office, it is critically important that automation must result in a substantial reduction of manual labor to perform a function or functions, otherwise the staff's workload will become heavier and less-fulfilling.

The next objectives cited by management

are to either improve the quality of the organization's output, or to enable the staff to accomplish a function that they could not reasonably accomplish before - such as to communicate by EDI.

Quality and internal consistency are common justifications for automatic solicitation software and automatic contract generators.

Similarly, management often seeks to use custom applications of accounting software to organize and report on contract financials. Automatic systems are often implemented to improve the integrity, accuracy, and storage of contract data.

Another objective cited by management is to use program management and tracking tools in order to improve internal control and oversight by management. Frequently, the workload in contracts offices is difficult to measure and balance. Some DoD offices have stolen a technique from defense contractors and have implemented internal cost control systems.

3. The Effects of Automation on Performance

In these days of cost-cutting and cost analysis, it is important, and sometimes illuminating, to examine the results of automation on contract offices in order to determine whether the investment achieved the original objectives.

In most cases, it appears to this writer that functional effort is saved - often substantially. Total workload, however, is NOT reduced, simply because the overall efforts are redistributed among functions. In most cases, this redistribution of effort has positive results. The staff is able to concentrate efforts on functions that they were not able to do before. In other words, the quality of output improves.

In some cases, it is not clear that automation accomplished savings in the workload (although different analytical approaches can come to different conclusions). If efficiency is an objective, and gains in efficiency are not achieved, then the automation project failed in at least that respect. When this happens, to either a greater or lesser degree, then the existing professionals in the office suffer, because they are usually required to do more work, in order to "serve the computer" and accomplish their principal work.

An important fact to note is that the overall results of automation are very difficult to predict. Often management is surprised - and frequently disappointed. And the people working in the office are often very surprised at the way their work has changed.

However, office functions of various types have been altered by automation for over twenty years, and some lessons can be applied to contracts offices in order to make the outcomes more predictable. Generally, the effects of automation depend on:

A. <u>The objective(s) to be achieved.</u> Whether cost or staff reductions are the only objective, or one of several objectives.

B. <u>The means selected.</u> Whether the approach is to automate an existing manual

function, without any changes in processes or responsibilities, or to use automation in concert with a planned and coordinated change in the office's processes. Often, the result of automation without a process change is disappointing. It requires substantial managerial effort and planning to effect process change through automation, but the results are usually positive. The means can be evolutionary - such as through a TQM process - or revolutionary - such as through Business Process Transformation.

C. The emphasis placed on user input and involvement. It is fundamental that users be a part of system design and implementation, and that they must be a part of the solution. Users must "buy into a project", for it to be acceptable to them. This is obvious when existing processes are being automated. It is even more important, and more difficult, to get "buy-in" when the processes themselves are being changed.

D. The success of the implementation phase. When the software is ready for installation, the software developer or vendor's objective is to complete acceptance testing and to receive sign-off. It is difficult for either party to concentrate on user training, data conversion and data quality, and to accomplish the required adaptations and alterations needed for a smooth transition.

E. Training. Whether or not the users are fully trained in the delivered software. This includes more than functional and technical training. It includes post-cutover training in the details and capabilities of the software.

F. Support during and after transition. Whether the software developers provide on-site support to the users of the new software during the transition phase after acceptance, but prior to system maintenance.

Many successful system developers use a process of "pro-active technical support" to provide technical services to users after cutover and initial use of the system. The theory is that users develop skills with software systems over a period of several months after cutover. It is during that period that on-site technical assistance is necessary and useful. Pro-active support often includes refresher training, advanced techniques, periodic user group meetings, and "feedback" meetings.

G. Motivation of the Users. If the users want the system, are involved in it, and believe that they have a stake in its successful implementation, then they will be champions of it.

One of the features most often requested by management, but less often requested by users, is system documentation. Although adequate documentation is necessary, especially for technical reference, most users depend on documentation less than management would expect. Quality documentation must be provided in all cases; however, it is insufficient by itself to result in success.

The end result is that in a number of cases, the original objectives are not attained, and the benefits of the investment are not realized. This can result in a loss of investment, a loss of time by users, or the use and reliance on a "sick" or incompletely implemented system for a long period of time.

Unfortunately, anecdotal evidence indicates that under-used and abandoned tools and automated systems are not uncommon in the contracts field. One vendor of a FAR retrieval system said that her product was the third such service purchased for use in one small contracts office.

The problem with automation of contracts office functions, and the reason why many projects are disappointments is that automation of a contracts office is an automation of a process. This is importantly unlike the automation of data, which is what is done when an accounting operation is automated. The difference is fundamental. We are usually accustomed to thinking in terms of automating accounting or personnel functions, where the system addresses data and records about data. The processes used by the data is usually relatively straight-forward.

In a contracts office, automation usually addresses processes, and usually there exists a number of ways to accomplish a function - all but one of which are not in current use. Use of the computer to do a process requires a change in habits, even if the functional process remains the same. If the functional process itself changes, as well as the procedure to use the computer, then users often elect not to use the automated system unless the immediate benefits are very high. As a result, contracts professionals face some extra risks, and have a great deal at stake when they automate.

4. The Effects on People

This analysis does not address the technical support people who service and maintain automated systems. Clearly, automation will require technical people to manage the software.

As a side note, the idea that an office can develop its own people to maintain a system is one of those myths that bedevil managers and cause significant suboptimal use of systems and tools. Maybe ten years ago, it was possible for certain motivated people to learn the innards of a system so well that they could eventually maintain it. But with today's sophisticated systems, that idea is a dangerous dream. When management installs a system, or an automated tool, it should recognize that it is also buying technical support services.

The present employees of a contracts office have an important stake in the way automation is accomplished, and in the end result of automation. They will be directly affected with respect to:

- The way they will spend their time in the future office
- Their professional development
- Opportunities for advancement
- Their income
- Job satisfaction

Although the end users are often passive observers, they should understand that they frequently have more at risk than management or the vendor. At some point, both management and the vendors have an interest in "declaring victory" and moving on. But the contract professionals have to live with the delivered system and make the best of it, or quietly bury it. They are the ones who can tell you whether the system serves them, or whether they serve the system.

If the system serves the objectives, then there will be more time for people to think, rather than simply function. For example, if a system is installed, there should be:

- Less manual clerical effort, and less need for secretarial support
- More people spending a majority of their time on Pcs, rather than writing at desks
- More sharing of information, and use of common (internally consistent) information
- More reliance on the system, so that system upsets become major office upsets
- More time on exception processing, less on routine

The opportunity also exists for people's functional skills to change, and for the requirements for skills to change in a significant way.

If automation is successful, then there will be less time in clerical functions, there will be more time for analysis, and for use of professional skills. There will be more time to choose among alternatives, and more pressure to make the right choice, and to properly analyze and document the choice.

As examples, one should probably expect increased demand for the following contract-related skill areas in procurement offices:

- Business Research (New Vendors)
- Economics (Cost-Price Analysis)
- Subcontracts
- Changes and Disputes

5. Lessons Learned

The record of automation, like most records, is that some projects succeed, and some fail. The bad news is that the projects in contracts offices that fail, or that fall short of success, are discouragingly numerous.

The good news is that it is not impossibly difficult to predict failures, or to identify troubled projects early in the development and implementation phases. Mid-course corrections CAN rescue troubled projects. And more importantly, early planning and management follow-through can greatly reduce the risks of failure.

Contracts professionals should be alert, and be involved in decisions about automation, because they have so much at stake, and because their involvement can be crucial to success.

The themes of this "lessons learned" section are that: (1) contracts professionals can affect the probability that their projects will succeed, (2) the purchase price of the software itself is just one component of the various costs that management should recognize when it automates; and (3) substantial planning and attention to detail by management and users can result in a much more effective system for the investment.

The types of decisions that contracts professionals can and should influence include:

- <u>The objective of automation selected by agency management.</u>

Whether automation is intended to improve efficiency, to improve quality, to control the process, or to reduce jobs.

- The strategy of automation selected by office management.

If automation is a **part** of a planned process change, rather than being imposed on top of an existing system, it stands a much greater chance of successfully attaining objectives. However, automation in conjunction with a change in process requires much more commitment by management, and more involvement by users. Process changes require significant planning, review and evaluation by participants. It also requires training and technical/functional support through the transition phase before and after cutover.

- Program and technical management during development and implementation.

Probably the single most-frequent reason why operational objectives are not attained by new procurements of most types of automated systems is **lack of capable technical people to support the procuring CO**. It is very difficult for government procuring offices to obtain and retain sufficient technical support. And it is difficult in the government environment to determine accountability for technical decisions, or for omissions. The CO should ensure that he or she has a good technical team, that they are dedicated to and accountable to the project, and that they remain throughout the project.

- The budget to change and adapt the requirements and design **DURING** development and implementation.

If the automation project extends over more than nine months or a year, management should hold sufficient funds available to adjust and modify the system, prior to cutover. If the users have altered their requirements, and the specifications have not been adjusted, then the government must accept a system that no longer meets its need - and is not likely to be successful.

- Efforts to convert data to the new system.

In many cases, a new system will use data, or provide data, that resembles, but is slightly different from the data in use, or the data needed by another system or process. It is very important that data be analyzed and that the appropriate actions be taken to either convert data to a usable form, or to provide an appropriate translator. Data is one of the end products of contracts offices, and if the data is corrupted or requires manual intervention, then the benefits of the investment are diminished.

- Data compatibility among systems (interoperability).

Many contracts offices have elected to purchase and use special-purpose tools to automate functions within the office. Of course the issue with tools is that they might not be exactly appropriate for the function of that office, or that they might produce outputs that require manual intervention to be used by another process. Interface tools and translators are not difficult programs for vendors to write and provide, but they must be precise and accurate. They can be memorable headaches.

It is a challenge to contracts professionals to take the time to do the analysis in the detail sufficient for interface programs to be written that solve interoperability problems.

The alternative to interoperability is for the users to have systems that require them to work for the computer, rather than the computer working for the users.

- Training and education (technical and functional).

Training budgets are often cut, when funds run short, yet what good is a new system if the users don't understand and can't use its capabilities? Unlike the experience with shrink-wrapped software, users of sophisticated contracts software rarely seem to be able to grow into the system. Instead, the system is not used.

Effective training can be formal or informal, but it must include a live system, and an opportunity for users to test the tool or application on a live system.

- The budget for technical and functional support during transition.

The transition phase is the phase from acceptance of the system, through training and cutover, and through the period until the users are completely comfortable with all the features of the system. On-site vendor support during this phase is very important for full utilization of the system by users.

- Planning for support staff after transition (during maintenance).

Vendors' prices for staff support are usually challenged by management because they perceive the value as being intangible and low, and that the prices are too high. In fact, the vendor's post-transition support is crucial to the use of most sophisticated tools.

Most professionals learn a system by using it, and having a near-by expert to refer to is highly cost-effective, and helps the project go smoothly.

- The budget for changes, enhancements, adaptations and adjustments after acceptance

Most contracts offices are unique enough that they will want their systems to be customized and enhanced. These costs are often small relative to the others, yet they can have significant benefits. Sometimes, adaptive changes are necessary for the system to accomplish its original objectives.

The real lessons to be learned are that: (1) the purchase price of the software itself is just one component of the various costs that management should recognize when it automates; (2) substantial planning and attention to detail by management and users can result in a much more effective system for the investment; and (3) a little investment in technical support **after** cutover is very worthwhile.

CONCLUSIONS

The number of ineffective or under-used automated systems in support of federal contracts offices is a cause for concern, because many of the functions of contracts offices are difficult to automate. Although contracting functions are complicated and

often ambiguous, the current automated tools and systems that are available can provide improvements to office outputs, and to the skill level and professional opportunities of the contract professionals in the offices.

If properly implemented and supported, the functional software now on the market can provide a major improvement to the workload and job satisfaction of contracts professionals. However, if automation is poorly planned and implemented, it can be a nightmare to the users and professionals. So the ones with a major stake in the long-term success of automation of contract offices are the professionals.

The means to successfully procure and implement automated tools and systems in contracts offices is to address the difficult issues described above. This means planning, budgeting and follow-through. Because the people with the greatest stake in success are the "users" now working in the offices, they should recognize the issues involved, and actively ensure that the issues are fully satisfied when, and after, software is procured.

1993 ACQUISITION RESEARCH SYMPOSIUM

MATERIEL ACQUISITION - PROCESS DEFINITION

ABSTRACT

A restructurning effort at HQ Army Materiel Command (AMC) created the need to clarify where AMC's missions and functions fit within the acquisition life cycle process. Attempts to analyze this process resulted in a complex and inconsistent set of data. We needed a standardized set of activities that could be tied to the life cycle process in a simple, convenient way.

In 1990-91 the Defense Science Board produced a model of the acquisition process. Working at HQ AMC, I rebuilt the model, retaining the DOD level framework, expanding it to include all phases of the life cycle acquisition process and revising it to reflect the new "5000" series guidance. I also included resource management and personnel activities.

The software that I used, Master Planner, permitted me to designate performing offices and define the processes and functions performed by the directorates and QMBs of HQ AMC in context of the DOD acquisition process. This road map provides visibility to subprocesses within the overall acquisition process and shows the interrelationships of offices and directorates. It also can serve as a library of TDA data and related information such as products, customers, regulations and cost benefit statements.

The model and software can be easily and legally used throughout DOD. The model is composed of dBase files and can be run on PCs. The structure of the model makes it easy for other commands or services to adapt the model and build upon it.

INTRODUCTION

In 1990 the Defense Science Board (DSB) was tasked to review the DOD Materiel Acquisition Process. Their objective was to shorten the time taken to acquire materiel by 50%. Originally the project was to be conducted in 3 phases: document the existing system; recommend improvements to shorten materiel acqusition time; and implement the recommendations. The first phase was to take 3 months using personnel borrowed from the services.

The task proved quite difficult and the first phase grew to consume about one and one half years. The longer than anticipated time caused a high turnover of personnel. This resulted in loss of institutional knowledge, changes in procedures, and disrupted communications. The most devastating occurrence was the resignation of Secretary Bettie and subsequent loss of political support. This resulted in the project being wrapped up near the end of phase 1.

In spite of these problems, they did produce a valid model of the acquisition process, covering the activities from identification of mission need to IOC. The model was in the form of a pert chart that showed the tasks performed (840 of them), the logical relationships between the tasks, and the time

required to perform the tasks. The activities making up the model are identified and sequenced by the phase of the acquisition life cycle process. The time data (time to perform and man days required) was, unfortunately, suspect, but the other parts of the model were considered valid at the completion of the study. Quantities of other data were collected, but this paper only concerns the pert chart.

At the time this DSB effort was being concluded, Headquarters, Army Materiel Command (HQ AMC), was undergoing a reorganization and reduction. The method chosen to conduct this reorganization was to have eight macro-business process action teams (PATs), later named quality management boards (QMBs), each map out their own processes and look for ways to reorganize that would result in manpower savings. Each PAT/QMB proceeded according to its own methodology and used its own formats and levels of details. The result was eight different plans that were very difficult, if not impossible, to link together and compare.

LTG Thomas, the DCG for RDA at HQ AMC, was briefed on the DSB effort and saw their acquisition model as a vehicle that might be used to standardize and define the eight differing processes that HQ AMC was documenting. The DSB model would also provide a complete picture of the acquisition process that could be used to envelop HQ AMC's processes and help define what work we were supposed to do and identify our customers.

I was tasked to import the DSB model into AMC and insert the activities described by each of the eight business processes. My objective was to standardize and define HQ AMC's processes.

MODEL DEVELOPMENT

The first step was to choose a software package that was adaptable to the data and could easily be used on our existing equipment and within our limited budget. I chose a software package that had been used for some of the work at the DSB and was designed to handle acquisition related information: MCSAM (Marine Corps Systems Acquisition Model). This software, now commercially offered as Master Planner, was already licensed to DOD and was readily available from the contractor, Strategic Financial Planning Systems, Inc. The software worked in a DOS environment and used dBase files, which had a large user support base. It also had a graphics and data entry and retrieval overlay to make data input and access very user friendly. Since the Marine Corps used both Army and Navy acquisition systems, the software was compatible with both acquisition systems and needed no modification to use with the Army's way of acquiring materiel. The software could also be used on any 386 personal computer (a 286 could be used if the data base were small).

The second step was to revise the data produced by the DSB. Because the model took so long to build by the DSB, it was made obsolete the day it was released because the acquisition process had changed: DA published the 5000 series of acquisition policy. So, with the help of the staff at AMC, I began the task of updating the process chart produced by the DSB. Since a complete and thorough revision was going to be needed, I also decided to expand the model to include the entire life cycle: from definition of the need through disposal of the equipment. The original model ended at IOC and contained 840 activities. Presently the full updated life cycle model contains 1377 activities.

After updating the model, I then began to overlay the activities performed by four of the eight macro-business processes at HQ AMC that were directly related to materiel acquisition. I retained the DOD characteristics of the model and identified those activities that were either owned or performed by HQ AMC. I defined ownership as that QMB that had the responsibility for integration of the activity, not necessarily control or responsibility for the activity. I then identified the DCS offices at HQ AMC that actually performed (expended manpower on) the activity.

In some cases, HQ unique functions had to be added. Most of these HQ functions were: policy, integration, oversight or evaluation. I inserted these new activities in parallel to the "product generation" activities usually performed by the program managers (PMs), major subordinate commands (MSC), or contractors. When I had the data available, I also included performance by organizations outside of AMC (e.g., TRADOC, DA). In this way, all the HQ activities could be defined in term of where in the life cycle model their work was performed, who or what triggered the HQ activity, and who or what was the customer. This would make it easier to identify the effect or importance of the HQ function for purposes of reorganization, divestiture or termination of an activity.

After adding the business processes that were directly related to materiel acquisition to the model, I then attempted to add those processes that were less directly or indirectly related to the life cycle process. The first "indirect" process that I added was resource management. Some of these activities fit directly into the existing model structure and could be tagged directly to the existing model elements. Other indirect activities had to be added in a parallel network and only linked in one or two locations where specific activities did tie into the existing model structure. When handling resource management tasks that were controlled by the timing of the planning, programing, budget, execution system (PPBES) I designated those tasks as "repetitive" to separate them from the other acquisition related tasks that were "phase" related. Thus I was able to accommodate, in one cohesive model, both phase controlled and calendar controlled tasks. Using these techniques, I then incorporated some of the personnel process tasks performed at HQ AMC.

DATA BASE AND MODEL DESCRIPTION

The software is designed to produce the following types of printouts and reports:

> Network diagrams showing the activities and their logical relationships.
>
> GANTT charts showing the time relationships of the activities.
>
> Activity reports showing any of a wide variety of possible information fields that relate to each activity.
>
> Logic reports showing the logical connections between tasks.
>
> A wide variety of resource reports showing dollars and manpower requirements either associated to an activity or expended in the performance of a related group of activities.

Cost reports that can be depicted in a tabular format, graphical format, or a bar chart format. Several different types of reports can be displayed, and a program budget can be easily accessed and manipulated.

The data base can be manipulated (sorted and selected) and printouts customized just as any dBase printout. The most frequently used printouts are already formatted for the convenience of the user by the Master Planner software, and are easily configured.

Another feature of the software is a "library" of tasks or actions which allows users to quickly and easily select specific parts of the large model and display only specific portions related to the users needs and orientation. It is possible to "tag" the activities to customize the data base and large comment fields are already provided for in the software. The library of activities has been created through extensive research into DOD and other government documents, specifications, and requirements. It is the school solution to many different acquisition scenarios, but can also be used to create historical perspectives and as a guide for policy. Direct access to the dBase files themselves also give the user flexibility for modifying the basic model.

The MCSAM model and software are DOD property and are easily and legally exportable to other DOD offices and activities. The software is designed to run in a DOS environment and will function on existing 286 machines found in most government offices. However, if the data base becomes large, the processing time and hard disk storage space will become practical limiting factors. 386 machines are recommended. The Master Planner software, an upgrade to MCSAM, will provide extensive and powerful program management and organizational functions

FUTURE EFFORTS

My next task is to add the remaining personnel related tasks and then to include base operation and information management activities into the data base. Concurrently with the addition of these tasks I will need to modify the model to match the changes occurring at HQ AMC. The acquisition process is dynamic and ever changing and the process to update models to reflect these changes is an ongoing operation.

The model will be used as the baseline for the Acquisition QMB at HQ AMC and future plans include expanding the data base to include details on the MSCs and other organizations that interface with the HQ.

As time and resources permit, the model could be expanded to be a complete centralized library of HQ AMC organizational information. The software has the capabilities to include, and integrate with the associated activities, the following types of information:

Regulations and laws that govern or control the activities.

TDA (table of distribution and allowances) data that supports the activities.

Manpower that is associated (performs) with the activities.

Time normally required to perform the activity (statistics could be associated with this measure to show the variance).

Products generated by these activities.

Customers using these products.

Narrative stating the impact of nonperformance (utility of the activity); what if not performed.

Adding and maintaining this data base appears to be manpower intensive. However, some of this data is already documented and periodically does get updated in separate data bases and in hard copy. Creating and maintaining a centralized and cohesive data depository would be a new way of doing business and should save effort in the long term. It would be able show the linkages of the data and allow easy access of related files. To some extent, this would be a change or reorganization of where existing data is recorded and stored, not a new data gathering and storage effort.

There are some minor software modifications that would make such a centralized data base easier to create and maintain. One task is to put it on a local area network (LAN) where everyone in a command could have easy access to it for the updating and retrieval of information that is pertinent to them (the program is LAN ready). A program modification would be creation of a single "window" or screen that would let a user have quick and easy access to all the data fields that relate to the TDA. Several windows, for simplified data entry, are already built into the Master Planner program (oriented towards the acquisition process rather than towards an organizational or TDA structure). Little effort would be required to construct another window to bring together the additional TDA elements described above.

BENEFITS

The model can be very helpful in serving as a road map to enable analysis to restructure subprocesses (e.g., the functioning of an office) within the overall acquisition process or larger organizational unit. It also provides the commander with a picture of his command and the interrelationships of his offices and directorates. Additionally, it can be of assistance to acquisition policy offices to lay out the structure of the life cycle materiel acquisition process and those players (performing offices) which are affected by existing policy and would be restructured or impacted by new policy. The software already allows construction of "what if" scenarios to show the structure, time and resource requirements of alternate environments.

The structure of the model makes it easy for other commands or services to adapt the data to describe the workings and relationships of their own offices and directorates as well as both subordinate and higher HQ. The model has been briefed to personnel at the Defense Systems Management College (DSMC) and the Air Force Systems Command has used it as a starting point for their own model building effort.

INFORMATION SOURCES

For information on the commercial version of the software, Master Planner, you should contact the developer:

Strategic Financial Planning Systems
Attn: Clancy McQuigg
2241-R Tacketts Mill Dr.
Woodbridge, VA 22192-3024

Phone: (703) 643-0818

For copies of the data base and printouts of the acquisition process chart, contact:

Ben Perchik, Operations Research Analyst

HQ AMC
AMCAQ-AP (Perchik)
5001 Eisenhower Av
Alexandria, VA 22333

(703)-274-8225/DSN-284-8225
Email:
bperchik@alexandria-emh5.army.mil

SUMMARY

Driven by the need for a standardized and cohesive picture of AMC missions and tasks, we have developed an updated and easy method to comprehend model of the DOD acquisition life cycle process. The model, using familiar dBase files and suitable for most personal computers, forms the basis for a library that can store a variety of information, all linked:

- HQ activities, both directly and indirectly (resource management and personnel) related to the life cycle process.
- Activities performed by other organizations such as the PMs, MSCs, DA, Congress, contractors, other commands, etc.
- Customers.
- Products.
- Time to perform.
- TDA information.
- Consequences of not performing the task.
- Regulations governing task performance.

The main uses of this data are to provide:

- A road map of the acquisition process to enable policy makers to more easily see the consequences of new policy and changes to the process.
- A permanent data base of TDA information linked to the overall missions and functions that assists in reorganizations and downsizings.
- A common library of information that, when put on a local area net, gives easy access to offices to update and reference.

The model and software (Master Planner) can produce a wide variety of graphic and tabular reports on selected and sorted data fields. They are easily and legally usable and available for modification and use throughout DOD.

AUTHOR

Ben Perchik, Operations Research Analyst
HQ AMC, AMCAQ-AP

STUDY OF THE RELATIONSHIP BETWEEN PERSONALITY CHARACTERISTICS AND ETHICAL SENSITIVITY IN BUSINESS

Ronald A. Ortiz, Capt, USAF
DPRO, Martin Marietta

David Petrillo, Capt, USAF
ASC Wright Laboratory

Abstract

This research establishes a statistically significant relationship between ethical sensitivity, which is the perception that ethics and ethical considerations are present in a given situation, and personality type, as characterized by the Myers-Briggs Type Indicator (MBTI).

A randomly stratified sample from the membership of the National Contract Management Association (NCMA), resulted in a research sample of 466 respondents. The sample was analyzed by segmentation into government (181) and private industry (285) respondents. The average response from the sample of 5.00 on a seven-point scale for the ethical sensitivity questions is considered high. Differences in the perceptions of ethical sensitivity were determined to be statistically significant among the government and industry segments, and among the ten questions describing scenarios faced by contracting professionals. In the majority of the questions, the government segment reported higher ethical sensitivities than the industry segment. However, industry reported higher ethical sensitivities to one question involving an arithmetic error causing a loss to the contractor. There was a statistically significant difference in the MBTI distribution of the sample compared to the data bank of the Center for the Application of Psychological Type (CAPT). The research sample contained more introverted, sensing, and thinking types than the CAPT sample. Among the government segment, it was established that those favoring intuition, and intuition and thinking as their cognitive functions, exhibit higher degrees of ethical sensitivity than other personality types.

Recommendations for additional research are provided.

Introduction

During the 1980s, the media exposed the public to several scandals involving the defense industry. In 1991, UNISYS Corporation was found guilty of civil and criminal charges of conspiracy to defraud the government, bribery, and filing false claims on government contracts. These convictions resulted in \$190 million in fines, penalties, and relinquished profits. Meanwhile, the Ill-Wind investigations which helped to convict UNISYS also resulted in additional convictions of 51 persons, and six other companies for various forms of malfeasance on other defense contracts (14:319). In 1990, Under Secretary of Defense for Acquisition John Betti resigned under fire after it was discovered that DoD officials misrepresented the extent and magnitude of the financial problems associated with the Navy's A-12 program (9:44). The program was subsequently canceled.

There have been similar occurrences in the Savings and Loan (S&L) Industry and among Wall Street's top brokerage houses. It is estimated that the Federal Deposit Insurance Company's bank fund has paid out \$56 billion to the depositors of failed S&Ls and that

an infusion of an additional $70 billion will be needed (4:30-32). Michael Milken, a noted Wall Street stockbroker from the Drexel Burnham Company, pleaded guilty to six felony counts involving insider trading, paid fines and restitution totaling $600 million, and was sentenced to ten years in prison (15:30).

As a result, the ethical behavior of individuals and organizations has come under increased public scrutiny. In fact, according to a 1987 Time Magazine study, 76% of the American public saw a lack of business ethics in managers as contributing to the decline of U.S. moral standards (7:261).

Significance to Government Acquisitions

In the midst of this turmoil, the federal government increased its regulatory interest in ethics, especially with regard to government, and particularly Department of Defense (DoD) acquisitions. Public Law 96-903, unanimously passed by Congress and signed into law in 1980, established a code of ethics for all government employees. The code contains ten basic principles including upholding the Constitution of the United States, exposing corruption whenever possible, and putting loyalty to the highest moral principles and to country above all else. In addition, Part 3 of the Federal Acquisition Regulation (FAR) contains further clarification and implementation procedures related to receiving or soliciting gratuities, disclosing proprietary information, post-employment restrictions of certain former and retired DoD employees, and other standards of conduct (11:16, 307-16,341).

The DoD became further involved in the area of regulating ethics when it issued Directive 5500.7, Standards of Conduct, in May 1987. The directive prohibits using inside information for personal gain, prohibits conflicts of interest, requires submissions of financial interest and affiliation statements, prohibits the release of acquisition information, restricts outside employment opportunities for DOD personnel, and establishes agency ethics officials and committees (3:1-24). In an attempt to provide further guidance to government procurement agencies and the defense industry, Congress passed the Procurement Integrity Act in 1989, which imposed both civil and criminal penalties for disclosing competition sensitive information to unauthorized sources. Individuals found guilty of violations under this act are subject to fines of up to $100,000 and a maximum prison sentence of five years (13:23).

With the passage of laws and the implementation of regulations, companies have recognized the importance of integrating ethical decision making into the corporate culture. According to a survey cited by Harrington, 63% of the Fortune 500 Chief Executive Officers believe that a strong ethical corporate culture is directly related to developing a strategic advantage that can result in long-term benefits and profitability (5:21). Companies are concerned with unethical behavior because it can lead to adverse public opinion, governmental intervention in the form of oversight and regulation, adverse organizational costs in the form of lost profits and goodwill, monetary penalties, criminal penalties, and even the loss of contracts.

The Packard Commission's February 1986 Interim Report recognized that there was public concern over "procurement irregularities" and suggested that "effective self-governance might

help to curb industry misconduct' (1:1). In response to the Commission's preliminary recommendations, representatives from eighteen defense companies drafted six principles which are now known as the Defense Industry Initiative on Business Ethics and Conduct (DII). The signatory companies pledged to promote programs and policies associated with a code of ethics, ethics training, internal reporting of misconduct, self-governance, industry responsibility, and public accountability (2:1). As of February 1991, fifty-five defense companies have become participants in the DII (Defense Industry Initiative, 1991:1).

Companies are not alone in recognizing the importance of promoting ethical awareness. Professional associations have also adopted codes for ethical behavior as part of their by-laws. For example, the National Contract Management Association (NCMA) has established six ethical standards their members are obligated to uphold. The NCMA Code of Ethics promotes behavior and professionalism among its membership.

Ethical Sensitivity

Establishing, promoting, and encouraging ethical behavior in an organization is a complicated process which begins with an assessment of the ethical awareness of employees prior to implementation of a formal program. This ethical baseline is necessary for management to determine which areas of ethical consideration warrant their concern, and to develop appropriate methods to influence employee attitudes and behavior concerning ethical practices.

Ethical baselining requires management to assess its employees perceptions of the degree to which ethics and ethical considerations are a part of their daily work-related activities. This leads to a new ethical construct which is not addressed in ethics literature. The degree to which one perceives one's decisions and actions as being affected by necessary ethical judgments will be referred to as the individual's ethical sensitivity. Take, for example, a situation where a contract administrator (CA) needs the signature of an administrative contracting officer (ACO) on a particular document. With the ACO unavailable and immediate completion of the document necessary, the CA is faced with the option of signing the ACO's name without his/her knowledge or permission. Ethical sensitivity does not address whether or not it is ethical to sign the ACO's name. Ethical sensitivity does address whether the CA perceives that the decision of whether or not to sign the name of the ACO is even a question of ethics. The CA may view this decision in terms of the propriety (right and wrong) or morality (good and bad) of signing the name, or may not even consider those issues and view it purely as a business decision involving the practicality of getting the document processed and assuming the responsibility. The degree to which the CA believes that ethics are involved in the decision, regardless of what that decision is, is the degree of the CA's ethical sensitivity.

The range of ethical sensitivities among the employees of an organization establishes the baseline which management must consider in developing and implementing ethical training programs.

Specific Problem Area

Management, concerned about their employees' sensitivities to ethical issues involving job actions

and decisions, should consider two questions in evaluating the organization's ethical baseline. First, what accounts for the differences in ethical sensitivity among employees? Second, is there an indicator which will accurately predict an individual's ethical sensitivity? The assumed notion is that management will be more effective if it understands the factors which bear upon an individual's ethical sensitivity and tailors programs to respond to those factors.

For example, an individual whose ethical sensitivity is strongly linked to a religious upbringing may respond favorably to an ethical awareness program which heavily stresses the moral implications of ethical behavior. With another individual, however, ethical sensitivity may be linked solely to the practical considerations of risk and risk avoidance. In this case, the program might be aimed at the negative repercussions of the discovery of unethical behavior.

Clearly the aim and emphasis of these two examples would be different. The discovery of some predictable indicator of an individual's ethical sensitivity would aid management in targeting groups of employees with like characteristics related to ethical sensitivity and structure programs which would effectively influence those groups.

Problem Statement

This research explores the notion that there are indicators which can help management predict the ethical sensitivity of an individual and understand the factors from which the sensitivity is formed. The indicator under consideration is personality type as characterized by the Myers-Briggs Type Indicator (MBTI) (11). This leads to the following problem statement, the answer to which is the objective of this research:

Is an individual's personality type, as characterized by the MBTI, an accurate predictor of that individual's ethical sensitivity?

Among other measures, the MBTI model of personality type characterizes the way individuals perceive and judge the world. It recognizes that there are distinct processes for the functions of perception and judgment and observes that individuals will exhibit a preference toward one process over another when given a choice. Behavior patterns in individuals are affected by these functional preferences and the combination of preferences manifest themselves in behavioral patterns which can be characterized into distinct personality types.

The MBTI assumes that the preferences are influenced by both genetic and social factors. As such, the model is less concerned about the origin of these preferences, addressing itself more to the manifestation of these preferences in behavioral patterns which can then be recognized and understood. Application of the model involves the study of possible relationships between the functional preferences and combinations of preferences, as manifested by behavioral and attitudinal patterns, and various dependent variables, such as ethical sensitivity.

Research Question

This research investigates the possible existence of relationships between personality type and ethical sensitivity among contract professionals. The research question is ated as follows:

What is the relationship between ethical sensitivity and personality

type, as measured by the Myers-Briggs Type Indicator, for contract professionals?

Personality type is chosen as the independent variable and ethical sensitivity serves as the dependent variable. The research tests for statistically significant relationships between these variables among a sampling of contract professionals from the membership of the National Contract Management Association.

Subsidiary Questions

The first task of this research is to determine the degree to which contracting professionals apply ethical considerations to the judgment of their actions and decisions. The results of this analysis determines an individual's ethical sensitivity. Then, the sample is categorized by personality type and the components of personality type, as described by Myers-Briggs type theory, and related to ethical sensitivity to determine if statistically significant relationships are present. This analysis is guided by a series of subsidiary questions, some of which are pivotal to the answer to the fundamental research question. Pivotal subsidiary questions are those whose answers directly affect the answer to the research question.

The following are the subsidiary research questions for this analysis. Note that each question except the first can be formed into a hypothesis statement which can be tested by statistical analysis. Since the model of ethical sensitivity is a new one, the answer to the first question provides only descriptive information. There is no data about ethical sensitivity in the general population with which to compare it.

1. What are the characteristics of ethical sensitivity among survey respondents?

2. Is there a statistically significant difference in the distribution of personality type, as characterized by the Myers-Briggs Type Indicator, among survey respondents and the general population?

3. Is there a statistically significant relationship between ethical sensitivity and the individual components of personality type, as characterized by the Myers-Briggs Type Indicator, among survey respondents (pivotal)?

4. Is there a statistically significant relationship between ethical sensitivity and specific combinations of personality components, as characterized by the Myers-Briggs Type Indicator, among survey respondents (pivotal)?

5. Is there a statistically significant relationship between ethical sensitivity and dominant function preferences, as characterized by the Myers-Briggs Type Indicator, among survey respondents (pivotal)?

6. Is there a statistically significant relationship between ethical sensitivity and the sixteen personality types, as characterized by the Myers-Briggs Type Indicator, among survey respondents (pivotal)?

Methodology

This research was conducted by analysis of responses to a survey addressing ethical sensitivity and psychological type. The sampling frame was the membership of the National Contract Management Association, which in part sponsored the research and provided a mailing list of its membership. Of the

23,900 names available, 1550 were randomly selected to receive the survey. There were 610 responses (39%), 466 of which were usable for this analysis (30%).

Survey Instruments. In examining the relationship between personality type and ethical sensitivity, personality type is determined to be the independent variable. This variable was measured using the Myers-Briggs Type Indicator. The dependent variable is ethical sensitivity which is a new construct developed as part of this research. Measurement of this variable required formulation of a new survey instrument which could accurately gauge the degree to which an individual perceives that the determination of actions or decisions in a particular situation requires some ethical consideration.

A review of information from the Center for Business Ethics at Bentley College and several defense contractor ethical handbooks were used in developing ten scenarios which represented likely situations that contracting professionals might encounter in the course of performing their jobs. This survey measures ethical sensitivity through the respondent's answer to the following question relating to each of ten separate scenarios: "To what extent do you agree or disagree that ethical considerations are involved in making the following decision?" The answers are arranged on a seven-point Likert as follows: 1) strongly disagree; 2) disagree; 3) slightly disagree; 4) neither agree or disagree; 5) slightly agree; 6) agree; 7) strongly agree. The ethical sensitivity variable, then, is continuous, with potential mean scores ranging from 1 to 7. The mean score of the answers to the ten scenarios is the respondent's ethical sensitivity score.

Survey validity was addressed the instrument trial test. This trial test was administered to nineteen Air Force Institute of Technology graduate students in the Contract Management program of study. Their responses suggested the instrument was indeed measuring ethical sensitivity in the respondents. This was confirmed in a subsequent session where the respondents discussed their perceptions of what they were being asked to provide in response to the scenarios. Their feedback provided the assurance that they gauged the degree to which ethical considerations were necessary in making a decision with regard to the scenario.

Analysis of the Data.

Statistical analysis of patterns of ethical sensitivity with regard to different independent variables required the use of mean analysis of different populations (McClave and Benson, 1991:393-453). In all cases, a statistical confidence level of 95% +/- 5% was sought.

Demographic Analysis. The demographics were grouped into two major areas: personal characteristics and job characteristics. The personal characteristics consist of gender, age, education level, and ethnic origin. The job characteristics are comprised of job title, position level, and years of experience.

Tables 1 and 2 summarize the demographic makeup of the respondents.

TABLE 1
PERSONAL CHARACTERISTICS OF RESPONDENTS
(N=466: 181 GOV; 285 IND)

	Government		Private Industry	
Gender				
Male	48.62%	(88)	72.63%	(207)
Female	51.38%	(93)	27.37%	(78)
Age				
less 25 Years	1.66%	(3)	1.40%	(4)
26 - 35	19.34%	(35)	17.89%	(51)
36 - 45	44.75%	(81)	31.93%	(91)
46 - 56	26.52%	(48)	27.72%	(79)
over 55 Years	7.73%	(14)	21.06%	(60)
Educational Level				
High School	11.60%	(21)	5.96%	(17)
Associate	11.05%	20)	7.02%	(20)
Bachelor	28.73%	(52)	40.70%	(116)
Masters	46.41%	(84)	43.16%	(123)
Doctoral	2.21%	(4)	3.16%	(9)
Ethnic Origin				
Caucasian	87.85%	(159)	94.74%	(270)
Black	5.52%	(10)	2.81%	(8)
Hispanic	2.21%	(4)	1.40%	(4)
Oriental	2.21%	(4)	1.05%	(3)
Other	2.21%	(4)	0.00%	(0)

TABLE 2
JOB CHARACTERISTICS OF RESPONDENTS
(N=466: 181 GOV; 285 IND)

	Government		Private Industry	
Job Title				
Admin/Contracting Officer	65.19%	(118)	69.12%	(197)
Buyer/Purchasing Agent	14.37%	(26)	17.89%	(51)
Clerical	1.66%	(3)	0.35%	(14)
Cost/Price/Financial Analyst	5.52%	(10)	9.12%	(1)
Other	13.26%	(24)	18.25%	(47)
Position Level				
Non Supervisory	56.91%	(103)	31.22%	(89)
Manager/Supervisor	31.49%	(57)	50.53%	(144)
Executive	11.60%	(21)	18.25%	(52)
Years of Experience				
0 - 5 years	16.02%	(29)	16.14%	(46)
6 - 10	27.07%	(49)	18.95%	(54)
11 - 15	30.39%	(55)	25.96%	(74)
16 - 20	19.89%	(36)	23.86%	(68)
Over 25	6.63%	(12)	15.09%	(43)

Ethics Policy Questions. The objective of the research in this area is to determine the extent that companies have written policies on ethics and to obtain information on the individual's perceptions regarding different aspects related to those policies. With respect to ethical policies, 89% (161 of 181) of government respondents indicate their organizations have written policies. It should be noted that 18 of the 20 government respondents who indicate their organization do not have a written policy governing ethical behavior are from the federal government level. This is unusual since ethics policies, and programs which publicize and require training of those policies, have been mandated by statute at the federal government level. These respondents seem unaware of those policies. As for industry, 85% (242 of 285) indicate their organizations have written ethical policies. Of the 285 industry respondents, 20% (58) are considered small businesses. Only about half of the small business respondents indicate their organizations have written policies.

Analysis of Ethical Sensitivity and Personality Type

Ethical Sensitivity. The first subsidiary question deals with the characteristics of the ethical sensitivity scores among the survey respondents. The mean ethical sensitivity score is derived for each scenario from all 466 responses. These scores indicate that the respondents as a group judged some scenarios to require a greater degree of ethical consideration than others. A comparison of the mean score of each scenario with the mean scores of each of the other nine scenarios reveals a statistically significant difference in the ethical consideration required of the two compared scenarios in 82.2% of the cases (37 of the 45 comparisons). Government employees in the sample report higher ethically sensitivity responses, overall. The literature substantiates that ethical awareness and training originated and were driven by the public sector. It is reasonable to believe that their longer emphasis on the subject and the maturity of their programs would combine to make them more sensitive to the ethical considerations involved in given situations.

There is only one scenario in which the private industry respondents had a higher level of ethical sensitivity than government respondents. In the scenario, a government contracting officer, while reviewing a final negotiation summary document provided by the contractor, discovers an error in favor of the government. The question concerns the ethical consideration involved in the contracting officer's decision of whether or not to notify the contractor of the error. Here, private industry respondents were more likely to view the decision as a question of ethics than were government respondents. This is consistent with Jones' notion of moral proximity, which states that one is likely have a higher level of morally intensity over issues that affect them (6:371). In this scenario, the contractor can be the victim or beneficiary of the government's action and, therefore, is sensitive to the ethics involved in that decision.

The discovery of a significant difference between the ethical sensitivities of government and private industry will be used in the analysis of the relationship between ethical sensitivity and personality type. The further stratification of the data by government and industry may uncover statistically significant relationships that would otherwise be masked when the

relationships are examined without government and industry separation.

MBTI Type Distribution. Next, the research seeks to determine if there is a difference between the distribution of personality types in the sample and the general population. A 1985 article in The Journal of Psychological Type offers three different data banks of MBTI respondents which are drawn from some cross-section of the general US population, (8:3-9). Each data bank, however, contains its own particular bias. Of the three, the data bank selected for comparison is maintained at the Center for the Application of Psychological Type (CAPT). This bank has over 23,000 records taken using Myers' Form F type indicator, and almost 16,000 others using the Form G type indicator. The respondents in these groups were significantly weighted toward persons with some amount of higher education. This bias tends to create a high percentage of introverts and intuitives who are more likely to go on to college and beyond.

A Chi-squared comparison of the populations reveals that there are statistically significant differences in the MBTI type distributions of the two populations. The research sample is shown to contain more sensing-thinking (ST) types than the CAPT data bank, particularly more introverted sensing-thinking types (IST) among women.

Relationship of Ethical Sensitivity and MBTI Personality Types. The next four subsidiary questions deal specifically with the relationships between components of MBTI personality type and ethical sensitivity. The data revealed that there are significant relationships between components of personality type and the respondents' perceptions of their ethical sensitivity. Specifically, comparison of the means revealed that intuitive types (Ns), particularly among government respondents, show significantly more ethical sensitivity than any of the other types. Further, intuitive-thinkers (NTs) tend to be more ethically sensitive than any other cognitive sets of personality preferences. This relationships are statistically proven to a confidence level of 95%.

There appears to be a relationship between ethical sensitivity and thinking types (Ts), as well, but this relationship cannot be statistically supported. Comparison of the means reveals confidence levels just under the required 95%. Also, there is a contradiction along the thinking-feeling scale among government and industry respondents. Government thinkers seem to be more ethically sensitive than government feeling types. Among industry respondents, however, feelers showed higher ethical sensitivity responses than thinkers. This apparent contradiction necessitates further research into the relationship between ethical sensitivity and the thinking-feeling preference scale.

There were no other statistically significant relationships revealed in the research. In fact, analysis of the sixteen personality types and their relationship to ethical sensitivity could not be performed due to the low frequency of responses among a number of the types (less than three in many cases). Analysis with these low frequencies was determined to be inconclusive.

Conclusions

The research question is answered in the following way: There is a statistically significant relationship between ethical sensitivity and personality type, as

characterized by the Myers-Briggs Type Indicator (MBTI). This relationship is established by showing significant correlations between intuitives (Ns) and intuitive-thinking types (NTs), and their ethical sensitivity responses on the ten scenarios.

The correlation between intuition and ethical sensitivity reported by this data seems sensible with respect to the characteristics of intuitive types. Intuitives are prone to look beyond the objective description of a situation toward the meanings of what they perceive. They seek "the broadest view of what is possible and insightful" given a particular situation (10:13). While reading the ten scenarios posed in the survey, intuitives are instinctively assigning meaning to the events as they unfold in the scenario. They consider the possible consequences of varying decisions and actions, and their insight creates a notion about the ethical considerations that should be involved in formulating those decisions and actions. Their perceptions about what requires ethical consideration are formed from the notions they get when reading the scenario, not an objective comparison of the scenario's events and what they know of ethics policy. Their preoccupation with possibilities makes them apt to see the potential ethical consequences in most situations which, therefore, may create a higher degree of ethical sensitivity.

Recommendations

Enhancement of the Survey Instrument. Ethical sensitivity scores were based on the responses of the survey population regarding scenarios that contract professionals may encounter in the performance or their duties. The scenarios involved both government and industry employees who were facing decisions that may or may not require ethical considerations. Future researchers should consider making the scenarios as generic as possible in order to eliminate any potential bias of business settings relating to the ethical sensitivity scores. The scenarios should be written such that there is no distinction made between government or industry employees. Another recommendation is to expand the scope of the survey by including scenarios about different business practices involving bribery, fairness, honesty, confidentiality, advertising, coercion, or self-interest. The scenarios would no necessarily relate to the defense acquisition industry and could be adopted from other related research efforts.

Ethical Policies. The research established that a large majority of the organizations have written ethical policies to guide ethical behavior. Also, the policies are distributed to the employees, training is conducted regarding the policies, and a large majority of employees agree or strongly agree with the policies. Further research should examine the differences between educational and training programs that are conducted by various organizations. The data should then be combined with ethical sensitivity and MBTI personality type data to examine whether education and training are moderating variables which affect ethical sensitivity. Furthermore, an analysis of the data should be performed to determine whether these programs influence some personality types more than others, and visa versa.

Additional MBTI Research. Subsidiary Question 3 examined whether a statistically significant relationship between ethical

sensitivity and individual components of personality types exists. As previously discussed in Chapters IV and V, the mean ethical sensitivity score for government thinkers (T) is higher than for government feelers (F). On the other hand, industry feelers (F) reported a higher ethical sensitivity score than industry thinkers (T). The contradiction warrants further investigation into the possible underlying causes for this finding. This should be accomplished by obtaining a larger sample size and expanding the scope of the survey to include more general business practices. A larger sample size will also provide additional data to examine the relationship between ethical sensitivity and the sixteen MBTI personality types.

National Contract Management Association. Since this research has established a relationship between ethical sensitivity and personality type, and because further research may expand these findings and better define their implications and use, the NCMA should make efforts to determine the MBTI personality types of its membership. An association-wide effort to administer the survey and make its results part of its national database will be useful not only for further research efforts, but in the implementation of recommendations involving ethical sensitivity that will likely result from that research.

Government and Industry Acquisition Organization. The relatively high ethical sensitivities reported by both government and industry respondents is an indication that the effort to increase ethical awareness has been successful, thus far. These programs should be continued and expanded to capture the relatively small percentage of respondents who seem to still be unaware of their existence.

Government and industry acquisition organizations are also advised to determine the MBTI personality types of their employees. By identifying personality types, managers can conduct their own research into the attitudes and influences of these types about ethics and ethical awareness and behavior. This may help to gain insights into ways to improve ethics programs to increase the ethical sensitivities of all personality types. As the body of knowledge involving ethical sensitivity and personality type increases, MBTI personality type information will become more valuable and useful.

Association for Psychological Type (APT). This research suggests a rich area of further study involving the Myers-Briggs Type Indicator. The APT should seek-out and sponsor initiatives which expand the scope of ethical sensitivity research and the relationships between ethical sensitivity and personality type. Wherever the MBTI can be used to expand the body of knowledge on a particular subject and, ultimately, improve interpersonal understandings and behaviors, it not only benefits the particular subject, it also benefits society as it is affected by that subject. It also increases the prestige and reputation of the MBTI model and type indicator. In this case, there exists the opportunity to further understand ethical attitudes and behaviors as they relate to personality type, and improve ethical behavior by developing ways to best influence different personality types about ethics.

Bibliography

1. Defense Industry Initiative Working Group. Defense Industry Initiative on Business Ethics and Conduct. 1987 Annual Report to the Public and the Defense Industry. Washington: Ethics Resource Center Inc., January 1988.

2. Defense Industry Initiative Working Group. Defense Industry Initiative on Business Ethics and Conduct. 1990 Annual Report to the Public and the Defense Industry. Washington: Ethics Resource Center Inc., February 1991.

3. Department of Defense. Standards of Conduct. DOD Directive 5500.7. Washington: Government Printing Office, 07 May 1987.

4. Foust, Dean and Mike McNamee. "How Deep is the Hole?" Business Week, 3943: 30-32 (9 December 1991).

5. Harrington, Susan J. "What Corporate America is Teaching About Ethics," Academy of Management Executive, 5: 21-30 (February 1991).

6. Jones, Thomas M. "Ethical Decision Making by Individuals in Organizations: An Issue Contingent Model," Academy of Management Journal, 16: 366-395 (April 1991).

7. Laczniak, Gene R. and Patrick Murphy. "Fostering Ethical Marketing Decisions," Journal of Business, 10: 259-271 (April 1991).

8. McCaulley, Mary H, and others. "Estimated Frequencies of the MBTI Types," Journal of Psychological Type, 9:3-9 (1985).

9. Montgomery, David. "How the A-12 Went Down," Air Force Magazine, 74: 44-48 (April 1991).

10. Meyers, Isabel Briggs and Mary H. McCaulley. A Guide to the Development and Use of the Myers-Briggs Type Indicator. Palo Alto CA: Consulting Psychologists Press, 1985.

11. Myers, Isabel Briggs and Peter B. Myers. Gifts Differing. Palo Alto, CA: Consulting Psychologists Press Inc., 1980.

12. Office of Federal Procurement and Policy. Federal Acquisition Regulation. Washington: Government Printing Office, 1990.

13. Shillito, Barry L. and others. "Congress Further Extends the Scope of Procurement Integrity," Contract Management, 29: 20-23 (September 1989).

14. "UNYSIS Pleads Guilty in Ill Wind Case; Agrees to Pay $190 Million," Federal Contracts Report, 56: 319-320 (9 September 1991).

15. Welles, Chris and Michele Galen. "Milken is Taking the Fall for a 'Decade of Greed'," Business Week, 3891: 30 (10 December 1990).

QUANTUM CHANGE '93

Morris O. Plaisance, DMDS-GBAF

ABSTRACT

Recycling and the preservation of our natural resources is becoming increasingly important to millions of Americans. Solid waste recovery is consistent with our standard of corporate responsibility of helping to improve the quality of life in neighborhoods, communities and municipalities nationwide. Recycling programs demonstrate that we can effectively solve the solid waste disposal dilemma. Changing behavioral characteristics of our employees toward resource recovery is necessary in order to accomodate the gradual change for future generations. Goals are achieved by improving sanitation technology, implementation and enforcement of sensible waste handling regulations, and our continuous efforts in public education. This whole throwaway approach flies in the face of traditional American values of thrift and common sense. Already costing us more than $10 billion a year, trash disposal is only getting more expensive. Other industrial countries produce half as much trash per person as we do, and recycle a major portion of it. Recycling offers America a way to deal with trash that is too good to pass up. Creating less waste and recycling more are clearly the most sensible steps, followed by safe incineration and landfilling. No single method promises a complete solution to the trash crisis, but recycling certainly has a starring role to play.

INTRODUCTION

Efficient implementation of our scrap recycling program is one of the most important challenges now confronting military installations today. The primary objectives of these programs are to conserve resources, minimize environmental pollution, recover strategic critical materials, maximize the net dollar return to the Federal Government and improve the quality of life programs for everyone.[1] The Solid Waste Disposal Act of 1965, as amended, requires that federal facilities comply with all federal, state, interstate and local requirements concerning the management and disposal of solid waste. Such requirements include permitting, licensing, and reporting. The Military Construction Codification Act (Public Law 97-214), which became effective 1 October 1982, expanded the Department of Defense (DOD) recycling program and required significant changes in DOD policies on the distribution of proceeds from sales of recyclable materials. DOD recycling programs pursuant to Section 2577 of Title 10, United States Code provide increased incentives for military installations to establish and operate efficiently recycling programs. By establishing a resource recovery program, installations may receive 100 percent of

the proceeds from the sale of waste materials and may accumulate up to $2 million from waste sales which may be spent on pollution abatement, energy conservation, and occupational safety and health deficiency abatement projects.[2]

TEXT

Voluntary recycling has grown into an important part of our nation's economy. It has given thousands of entrepreneurs an opportunity to start profitable and rewarding businesses. And, it provides tens of millions of dollars in added income to the recycling public and creates countless employment positions nationwide. The recovery effort to organize operations that require concerted efforts by concerned individuals to divert or recover scrap or waste from waste streams, as well as efforts to identify, collect, properly segregate, and maintain the integrity of the recyclable materials in order to maintain or enhance the marketability of the material are steps in the right direction for all. For many, recovery of recyclable waste will never warrant any concern until it's too late. A functional program is not made up of one person doing a lot but rather a lot of people doing a little. Only than will a recovery effort become feasible.

More so today than ever before are individuals becoming aware of landfill closures, illegal discards lapping up on our beaches with each incoming tide, barges of infectious waste traveling our coast line looking for a suitable dump area with prior coordination, and, in some instances, without any coordination. Behavior characteristics of our employees toward resource conservation are necessary to create solutions and alternatives in our changing world. Growth in our industry today is riddled with an increase in waste spills, ozone layer deterioration and the lack of concern to do what is right for the betterment of others. No longer can we as a people continue to bury the objectionable in landfills, burn the undesirables in incinerators, or otherwise dispose of material in a manner harmful to the environment and wasteful of our natural resources. Only positive attitudes in a positive environment regarding a team effort will create change in areas where change is difficult. Commitments to the quality of air we breathe, commitments to education, commitments to a quality workforce, and commitments to the removal of recyclable waste from the waste stream are no longer to be taken lightly but are necessary to preserve what we have grown to enjoy in this country.

Expenses of operating and improving recycling programs must be accumulated and reimbursed from proceeds of sales of recyclables prior to any other disposition of revenue. The recovery effort by government installations cannot operate efficiently if reimbursement of revenue to the generator is not done in a timely manner. Proceeds from the sale of recoverable waste at government installations with qualifying recycling programs shall be deposited in a special accounts to be so designated "Budget Clearing Accounts". The accumulation of funds in this suspense account is not affected by fiscal year end, so proceeds acquired during one fiscal year may be carried forward and merged with proceeds of subsequent fiscal years. The proceeds shall be segregated with the account to allow accounting as to the amounts collected and their disposition.

The following items are of significant importance: 1) Proceeds shall first be withdrawn from the suspense account to cover all the costs of operations, maintenance, and overhead for processing and handling the recyclable materials (including the cost of any equipment purchased for recycling purposes). 2) If the balance of an installation's proceeds remaining in the suspense account exceeds $2 million at the end of a fiscal year, the amount in excess of $2 million must be deposited into the U.S. Treasury as miscellaneous receipts.[3]

Waste products which are collected and stored on a government installation become government property and must be disposed of through the services of the Defense Reutilization and Marketing Office (DRMO). Procedures for the disposal must comply with those as outlined in the Defense Disposal Manual DOD 4160.21M. The DRMO of the Defense Logistics Agency (DLA) is responsible for negotiating sales of waste material from military installations. In the past, the generating activity received a percentage (about 80%) of the proceeds from the sale of recyclable materials. The new rules stipulate that all proceeds be returned to installations with an established Qualified Recycling Program (QRP). The QRP is one organized operation that requires concerted efforts to divert or recover scrap or waste from waste streams, as well as efforts to identify, segregate, and maintain the integrity of the recyclable materials in order to maintain or enhance the marketability of the materials. Activities having prior agreements with DLA/DRMO for waste sales must comply with the new provisions of PL 97-214 to receive 100 percent of the sales proceeds.[4] Military installations not located in the same vicinity or far removed from a servicing DRMO are encouraged to participate in a waste recovery program. However, because of their geographic location, instances have surfaced which deter the probability of success. Numerous publications outline the disposition of recoverable waste products from government installations and often outline the merits of a waste to energy program. Although adequate when initially written, times have changed. The recovery effort is more defined and not all installations can participate. DRMO's are burdened with the disposal of serviceable products or products which can be classified as those which can be used for their intended purpose. Products of this nature are not considered recyclable. Priority has shifted from and rightfully so, to the disposal of the items which can be moved most rapidly from the staging areas. Normally, miscellaneous scrap does not move rapidly and the accumulation becomes unattractive to the general appearance of onlooking management personnel. It needs to be stockpiled into lots, allowed to accumulate in sufficient quantities to increase it's value, and source separated to increase it's integrity. All of this requires a concerted effort from those individuals directly involved in the process.

Change for the future is necessary to remove waste from the waste stream. Individuals participate when the procedure is comfortable, paperwork is minimized and profits realized. Instances do arise where the servicing DRMO cannot handle the sale and disposition of merchandise, which has been collected and stored in a warehouse, in time frames commensurate with the collection. Established proce-

dures for the sale of recyclable waste do take time. Material inspection, contract preparation and advertising all lengthen the process. Products not brought to markets quickly lose their value, storage space diminishes, and continuity in program operation along with the integrity of the products decrease.

The provisions in appropriate government directives need to accommodate situations which may be beneficial to the government and assist in the reduction of the enormous amounts of waste in the waste stream. Revised and/or implement procedures for the stockpiling of recyclable waste in designated locations after natural disasters in most cases has not been addressed. For example, due to the destruction by hurricanes, fires, earthquakes, floods and other disasters, there are recyclable wastes generated in great quantities. These may include aluminum and other metals, aircraft, and timbers. Present procedures in most instances only include removal and disposal by burning and/or burying in landfills. After the emergency has come under control in terms of human suffering, and the restoration process begins, it would be profitable to the government to have emergency recycling procedures. Perhaps this could be in the form of special teams that recover and transport materials to designated areas. The net gain can only be beneficial, to include monetary recovery. Our present discarding sometimes only allows for partial recovery by private individuals or companies. It is time to implement local operating procedures to sell certain scrap materials due to insufficient quantities and/or in in the absence of a recycling program or servicing DRMO. Otherwise, recoverable waste will be disposed of as municipal trash and garbage; i.e., waste paper, corrugated, cullet, lumber, rags, bones and fats, grease, wood scrap, batteries, pallets, rubber scrap, plastics, tile, concrete, bricks and clay, ferrous/nonferrous metals if no contract exists, containers, and other material too numerous to mention.

Market sources available for the sale of recyclables collected by our government locations are not always exploited down to the local level by the DRMO. Profitable local markets for recyclables are frequently unused when limited quantities or a market price decline prevents a sale on a regional basis. Also, disposal through the local DRMO may prove impossible if adequate storage volume is limited at that site and prevents the accumulation of the large quantities needed to made DRMO sales contracts attractive to bidders. These conditions release the DRMO from their obligation to accomplish the sale of the product for the government when bidders do not respond.[5]

CONCLUSIONS

Inefficient waste management practices used in the past, such as burning in open dumps are no longer environmentally or economically acceptable. Problems in today's industrialized society, such as the growing volume of solid waste, air, water and land pollution, and rising materials cost are being countered with programs for waste reduction, stringent regulations for environmental protection, and requirements for recycling and resource recovery. Cost effectiveness of recycling and resource recovery purports that the net cost of such operations will be equal to or less

than that of conventional incineration or sanitary landfill disposal. Today, the environment is considered to be a single, integrated system characterized by the continuous interaction of air, land and water. This system should be regarded as closed; nothing can be thrown away. Wastes must either be recycled, reclaimed, repaired or confined and contained so they will not reappear in a pollutant form.[6]

As managers of the public trust, the government would be derelict in it's public trust responsibility to allow such exigencies of regional markets to prevent capitalization of all recyclable refuse resources, even if on a modest local scale. Considering the fact that some strategic metals are not found in North America, above-ground mining in salvage yards may be the only source of procurement during periods of hostility. Metals which can withstand high temperatures are necessary in the manufacturing of critical components of the weapons of tomorrow, i.e., engine parts, guidance systems, etc. Additionally, we have an obligation to the environment and to our limited natural raw material resources to return expended products to the waste stream, so long as the activity is self-supporting. When a regional or area buyer cannot be found to profitably serve a specific location, the installation then has products on hand which the DRMO is not obligated to accept. The installation then faces a cost for disposal rather than a profit situation. Costs to the government can be reduced in this area alone, by not incurring an additional disposal cost for a recoverable product.[7]

We should bypass the knot tying procurement procedures of advertising and vendor chase if the outcome is in the best interest of the government. This would allow profitable sales to smaller salvage companies in the commuting vicinity of a military or government installation.

Based on the existence of the above conditions, individual government locations need the authorization to search, exploit and utilize localized markets for sale of waste products without using the administrative and/or sales structure of the DRMO system. To comply with current and future requirements, innovative management is needed at all levels of responsibility to close gaps and create change. Enable commanders latitude and flexibility to establish markets, implement local operating instructions and determine what is best for their installation. This quantum change will foster ones imagination and is innovative. Implementation will strengthen the defense industrialized base.

NOTES

[1] "To Defense Logistics Agency Personnel", 14 Mar 85, Selected Letter of Brigadier General Thomas B. Arwood, (Commander: Defense Property Disposal Service Battle Creek, Michigan, Commander's Guidance Statement (CGS) NO: 21.

[2] Laws of the 7th Congress 2nd. Session, P.L. 97-214, July 1982, 96 STAT. 172.

[3] HQ AFAFC, Msg.,

Memorandum Directing The Transfer, (Lowry AFB, Co.), dated 011200Z Jul 83.

[4] "USAF Moral Welfare, and Recreation," Guide For Developing A Resource, Recovery, And Recycling Program, HQ AFMPC/DPMS, Randolph AFB, Tx.

[5] Letter received from Chuck West, HQ AFESC/DEM, Trash and Waste Recycling (TWR), 12 Jun 1985.

[6] Army PAM 420-47, Solid Waste Management, June 1978, p. 1-2.

[7] Letter received from Chuck West, HQ AFESC/DEM, Sales of Recyclable Materials (10 USC 2577), 18 Jun 1985.

ACHIEVING PUBLIC ENDS WITH PRIVATE MEANS: THE GOVERNMENT'S ACQUISITION OF R&D FROM FFRDCs

Douglas L. Sanders, Jet Propulsion Laboratory

ABSTRACT

Federally funded research and development centers (FFRDCs) are private, nonprofit organizations that perform R&D almost exclusively for a single federal agency. They often look like public organizations because they work closely with their sponsoring agencies and have "insider" access to information on agency plans and programs. Many in the public sector think FFRDCs have too much influence over agency decisions and circumvent civil service and procurement regulations. The private sector criticizes FFRDCs because they do not compete for work received and are supposedly inefficient producers. This paper uses a historical perspective to illuminate the current policy issues surrounding FFRDCs, including the policy implications of FFRDCs as potential competitors with other research and development (R&D) performers and the advisability of converting other performers to FFRDCs. The paper concludes that FFRDCs fill an important niche as performers of R&D that cannot be easily filled by others.

INTRODUCTION

When Dr. J. Robert Oppenheimer was selected by Major General Leslie Groves in the fall of 1942 to administer a classified laboratory at Los Alamos, N. M., both men assumed the facility would follow conventional practice and become militarized. Given the source of funds, the lab's mission to develop the first atomic bomb, and the need for security, it was assumed that scientists and engineers would be commissioned as army officers. But several key scientists refused to join the Los Alamos team under conditions of military hierarchy and bureaucracy. Science, they believed, thrived when scientists were free of bureaucratic constraints and judged according to their competence.[1]

In a February 25, 1943, letter to Oppenheimer, General Groves relented, promising that Los Alamos would be a civilian operation managed by the University of California under an Army contract. The Groves letter was the first deliberate step in legitimizing a new type of institution that came to be known as the federally funded research and development center. It also explicitly recognized that the type of institution performing R&D matters. Even General Groves came to recognize that this new approach worked far better than the militarized arrangement. While the scientists at Los Alamos were concerned about freedom of scientific inquiry in a military setting, the concern has implications for scientific inquiry on the civilian side as well. This is just one issue that has arisen in trying to accomplish public ends with private means.

It is somewhat paradoxical that democracy and science flourish in the same libertarian climate. As former Caltech president Lee DuBridge noted almost thirty years ago, "in a republic many people are concerned with government. On the other hand few people are directly concerned with science. How can the many be made to understand the contributions and the problems of the very few? This is a major problem in any democracy."[2]

Using a methodological approach that is essentially historical, this article attempts to show that the FFRDC concept is an effective means of reconciling the needs of the few to the legitimate concerns of the many, while harnessing the talents of the few to the service of the many as represented by the federal government. The approach lends itself to answering some key questions about FFRDCs, including: Why and how were they created? What factors contributed to their institutional design? What advantages and disadvantages do they have as performers of R&D? How are they different from profit-making contractors? What caused the later conflicts between FFRDCs and other institutions performing federal R&D? And perhaps most importantly, should the FFRDC model be expanded to other government-funded R&D efforts? This paper looks primarily at

research, multi-program, and studies and analysis FFRDCs that have discretion to initiate and manage elements of their own R&D programs. Other FFRDCs, more appropriately characterized as government-owned, contractor-operated (GOCO) facilities, are not the primary focus.

DEFINING FFRDCs

What exactly are FFRDCs? The National Science Foundation (NSF) defines them as "R&D performing organizations exclusively or substantially financed by the federal government . . . either to meet a particular R&D objective or, in some instances to provide major facilities at universities for research and associated training purposes. Each center is administered either by an industrial firm, a university, or another nonprofit institution."[3] The following criteria must be met before the NSF includes an organization in the FFRDC category:

1. Its primary activities include R&D, management of R&D, or a combination of these activities;
2. It is a separate operational unit within a parent organization or a separately incorporated organization;
3. It performs work either at the government's request or under a broad government charter, but always under direct government monitorship;
4. It receives most financial support from one agency;
5. It has a long-term relationship with its sponsoring agency as evidenced by specific obligations assumed by each;
6. Most or all facilities are owned by, or are funded under contract with, the government; and
7. It has an average annual budget of at least $500,000.[4]

These criteria do not clearly distinguish FFRDCs from private, profit-making government contractors, particularly certain cost-type defense contractors. Only criterion 5. somewhat distinguishes FFRDCs from government contractors, and even it could be interpreted as applying to profit-making contractors. Indeed, it may not be possible to clearly distinguish between FFRDCs and their profit-making brethren. The only other plausible distinguishing factors relate to the market environment in which profit-making contractors supposedly operate. More on this below.

THE EARLY FFRDC EXPERIENCE

Los Alamos was not the first FFRDC-like arrangement. That honor should probably go to the Applied Physics Laboratory at Johns Hopkins University, which was organized in 1942 at the request of the Office of Scientific Research and Development (OSRD).[5] The laboratory directed an association of universities and industrial contractors developing new concepts for weapons systems.[6] Other wartime FFRDCs included Harvard's Underwater Sound Laboratory, the M.I.T. Radiation Laboratory, and the Jet Propulsion Laboratory (JPL) at Caltech. JPL, started by the Army in 1944 under a contract with Caltech, was transferred to the National Aeronautics and Space Administration (NASA) in 1959.[7]

After World War II FFRDCs flourished. Several agencies, including the NSF, Atomic Energy Commission (AEC), Department of Defense (DOD), and NASA expanded existing FFRDCs or sponsored new ones. Some FFRDCs were formed to circumvent the "bureaucratic delay inherent in government."[8] Other reasons why agencies sought support from groups of outside experts via FFRDCs, included (1) low government pay scales for professionals, (2) a conscious desire to prevent agencies from developing large permanent technical staffs, (3) the need for independent technical judgment, (4) the increasing scientific and technological complexity of major new systems, and (5) the specialization required to develop new, highly complex systems.

Building on the wartime experience, the Atomic Energy Act of 1946 created the AEC to produce weapons-grade nuclear materials for DOD, develop reactor technology for the private sector, and regulate commercial reactors. R&D facilities created or assigned new responsibilities under the Manhattan Project played a critical role in postwar science and technology develop-

ment. The most important were the Metallurgical Laboratory of the University of Chicago, Ernest Lawrence's Laboratory at Berkeley, the Clinton Engineering Works which became the Oak Ridge National Laboratory, the Hanford Engineering Works, and the Los Alamos Scientific Laboratory.

The AEC deliberately chose not to operate the laboratories inherited from the Manhattan Project, even though the Atomic Energy Act specifically provided for federally-conducted R&D. In his book Contracting for Atoms, Harold Orlans characterized this policy as "self-denying" and "remarkable." However, he offered several reasonable explanations why a majority in Congress and the AEC did not favor government operation of major R&D installations:

1. Most key industrialists and scientists opposed it, because they believed military or civil service management would be less effective than private management and would make it difficult to attract the best people.

2. Allowing private organizations to manage government-owned laboratories was the only way to ameliorate AEC's "draconian powers" that abrogated traditional rights of private ownership and the free exchange of information.

3. Contracting with private organizations allowed the migration of knowledge, ideas, and advice "from a larger and more distinguished number of industrialists and scientists than would otherwise have participated in Commission affairs."[9]

The legal mechanism for this public/private endeavor was the "administrative contract" under which private organizations, including universities, other non-profit corporations, and commercial companies, agreed to manage AEC laboratories for the government. Commercial companies typically received small management fees, but also benefitted from the experience their employees received and the transfer of new technology.[10] These contracts envisioned a relationship between FFRDCs and their sponsors that was different from the relationship for typical government procurements. The latter were (and still are) conducted on a competitive basis through arm's length bidding or negotiating for specific products or services. The former presupposed a long-term, cooperative relationship involving continuous interaction between contractors and sponsors to determine what the parties would provide. Although the sponsor determined an FFRDC's basic direction, approved its long-range plans, and played a role in administrative matters, the FFRDC managed the work.

In short, administrative contracts allowed the AEC, and other Government agencies later, to capture a part of the scientific community for its own purposes, while preserving the flexibility, freedom of inquiry, and reduced bureau-demanded by scientists.

The Department of Defense (DOD) reached the same conclusion about the need for FFRDCs, but for somewhat different reasons. The primary issue for DOD was how to obtain unbiased policy advice in advance of agency needs. FFRDCs (called Federal Contract Research Centers in DOD) like the RAND Corporation and the Institute for Defense Analyses (IDA) were established for this purpose. RAND's charter became a model for later defense-oriented FFRDCs in its commitment "to further and promote scientific, educational and charitable purposes, all for the public welfare of the United States of America."[11] As a side benefit sponsoring defense agencies hoped FFRDCs would be catalysts for innovation within the agencies.

RAND is engaged primarily in long range research and analyses to aid strategic and technical planning. Unlike many of the AEC FFRDCs, RAND was not established to manufacture hardware as deliverable items to the government. This enhanced its image as a provider of "disinterested" advice, as it had less incentive to slant its work product in an effort to obtain follow-on production work. RAND had a direct hand in establishing two other FFRDCs. The Systems Development Corporation (SDC) was spun off by RAND in 1956 to help design and program the first computerized air defense system. RAND also fostered Analytic Services Inc. (ANSER) to provide quick reaction analyses of problems incident to planning for the R&D of aerospace weapon systems.[12]

Several special purpose FFRDCs were created after World War II to assist the Air Force with technology development thrusts initiated during the war. The Lincoln Laboratories, a lineal descendant of the wartime Radiation Laboratory at M.I.T and the MITRE Corp., which oversaw integration of the air defense system. The largest Air Force FFRDCs was the Aerospace Corporation, founded in 1960. The corporation provided technical direction and systems engineering for the Air Force's ballistic missile and space program. Before 1960 this task was performed by what one congressman described as a "hardware-oriented, profit-seeking private contractor."[13] The Military Operations Subcommittee, House Armed Services Committee, noting the importance of disinterested advice, recommended that the Air Force shift this work to "a nonprofit institution akin to the RAND Corp. and other . . . organizations which serve the military departments and other agencies of the Government on a stable and continuing basis."[14]

The Air Force was not alone in sponsoring FFRDCs in the post-war years. The Defense Department sponsored IDA in 1956 to conduct studies on the rationale of defense R&D programs and on national security policy matters. The Army fostered the creation of the Research Analysis Corporation (RAC) in 1961 to conduct operations research. RAC succeeded the Operations Research Office operated by Johns Hopkins University. In 1962 the Navy established the Center for Naval Analysis (CNA) as a division of the Franklin Institute in Philadelphia.

It was anticipated that the need for many DOD FFRDCs would be temporary. However, they became increasingly valuable because of their success in attracting many talented professionals with special skills and expertise in diverse fields. This led to a continuing flow of new and extended requirements for their special services which caused them to increase both in number and size. Increasing demands for the services of FFRDCs resulted in their becoming sizeable private organizations. Growth was accompanied by expansion and diversification, which attracted other clients. These included federal civilian agencies and organizations outside the government.[15]

FFRDCs AND THE POLICY PROCESS

Were FFRDCs legitimate from a public policy perspective? I have found very few references to any of the steps normally associated with the public policy process. It appears the AEC (and later DOD) identified the problem (lack of a suitable institution to perform certain types of R&D), formulated and adopted the preferred policy (creation of FFRDCs), administered programs, and evaluated results, with very little debate in Congress or elsewhere. This is not exactly what one would expect today given the economic and political implications of establishing a new institution to perform R&D. Not only was debate limited, but there was little protest from the other performers of R&D.

There are four plausible explanations. First, with the advent of the Cold War, defense-related scientific research was conducted in an atmosphere of urgency, if not crisis. DOD and AEC were given great discretion in their pursuit of defense-related scientific objectives. It would have been imprudent at best and unpatriotic at worst to interfere with the exercise of that discretion. Second, government R&D on such a large scale was a new phenomenon, dating only from World War II. Industrial and university performers were new to their roles as recipients of major and continuous defense funding. Perhaps they did not protest the advent of FFRDCs because they did not view themselves as possible future competitors of FFRDCs for federal R&D money. In fact, as the parent organizations for most of the large FFRDCs, universities anticipated substantial benefits in the form of research opportunities for faculty and students, and fees for operating the centers.[16] A related explanation is that the full plates of the other performers led to complacency about the amount of R&D funding that went to FFRDCs. The last explanation concerns capacity. Both proponents and opponents of FFRDCs agree that neither the university community nor industry was capable of amassing the array of expertise required to meet certain specialized government demands for R&D following World War II.

VISIBILITY LEADS TO CONFLICT

From the late 1940s to the early 1960s the role of FFRDCs does not appear to have been controversial, even though they were receiving 16% of federal R&D obligations by 1955 (Table 1). The issue of which institutional performers should get what in terms of R&D dollars was addressed in the 1962 "Bell Report" to the President. The report was authored by the heads of DOD, AEC, NASA, NSF, and the Civil Service Commission. It concluded that, "in selecting recipients, whether public or private, for research and development assignments, the basic rule . . . should be to assign the job where it can be done most effectively."[17]

In 1967, the Federal Council for Science and Technology prescribed criteria for identifying FFRDCs and developed an official master list. In 1971, NSF listed 70 FFRDCs; 27 were small educational laboratories funded by the Office of Education,[18] the AEC accounted for 21, DOD sponsored 15, and 7 were sponsored by other agencies.[19] These early lists, by establishing FFRDCs as a separate category of R&D performer, called attention to their institutional character--something that had not been done when they were established. Budget data generated as a natural supplement to the lists was instrumental in highlighting for Congress, the public, and other performers the share of R&D funding that went to FFRDCs.

The public policy debate over the institutional character and role of FFRDCs, which did not occur in the 1940s and 1950s, finally took place in the late 1960s and early 1970s. Criticism of FFRDCs came from Congress, industry, the print media, and academia. Even though the FFRDC share of federal R&D obligations had dropped to nine percent, critics were concerned that FFRDCs (1) were relatively free from congressional control, (2) had too much influence over DOD policy making, (3) were a subterfuge to avoid the restrictions of civil service salary scales, (4) had outlived the rationale for their creation, (5) were not subject to normal restraints of the competitive marketplace, and (6) were exempt from the restrictions of government regulations. Where universities were parent organizations of FFRDCs, the complaint centered on university support for classified military research. Campus protests were an important factor in the decisions of M.I.T. and Columbia to change their relationships with Lincoln Laboratories and IDA, respectively.

Issue (2) is of particular interest. The influential advisory role of some FFRDCs, such as RAND and MITRE, caused some in Congress to fear that decision-making responsibility, which they saw as the duty and privilege of government officials, was being contracted out. This concern is similar to Frank Fischer's concerns about technocracy, which he defines as "a system of government in which technically trained experts rule by virtue of their specialized knowledge and position in dominant political and economic institutions."[20] Perhaps congressional concern over the influence of FFRDCs on DOD policy making was a precursor of the technocratic concerns many have today.

By the end of 1971, the House Committee on Appropriations concluded it was time for a change in philosophy regarding the use of DOD FFRDCs. The committee directed DOD to reduce its use of RAND, RAC, CNA, and IDA, and recommended cutbacks of 25% in the budget requests for each FFRDC in fiscal year 1972. The committee also indicated it expected further cutbacks in future years.[21]

However, in response to pressures from FFRDC parent organizations (mostly universities) and Congress, DOD had already begun to decrease the number of FFRDCs it sponsored. In the early 1960s DOD sponsored 39 FFRDCs.[22] By 1967 that number had dropped to 18 and by 1972 it decreased to 12. In 1976 only 6 DOD FFRDCs remained. Some of the organizations struck from the list of FFRDCs included the Applied Physics Laboratory at Johns Hopkins, the Advanced Research Laboratory at Penn State, and ANSER.[23] Also, the number of professional staff members employed by the three remaining FFRDCs the committee was most concerned about decreased from 975 in 1967 to about 660 in 1975. Even with the reductions, however, DOD continued to consider these studies and

Table 1
FFRDC Share of Federal Obligations for R&D (Billions $)[24]

	1955	1960	1965	1970	1975	1980	1985	1990
FFRDCs:	.4	.8	1.2	1.4	1.9	3.4	5.3	5.9
Total:	2.5	7.6	14.6	15.3	19.0	29.8	48.4	62.3
FFRDC %:	16%	11%	8%	9%	10%	11%	11%	9%

analysis centers their best source of high-quality, independent professional judgement on various policy issues.[25]

The FFRDC controversy may appear to have been a tempest in a teapot given the small part of the federal R&D budget that went to the centers during that period (see Table 1). However, FFRDCs directly or indirectly influenced a much larger share of expenditures for R&D and hardware procurements. Moreover, they had a disproportionately great influence on U.S. R&D achievements because of their concentration on missions of national significance. Almost all industrial organizations contracting with DOD or AEC were affected by the results of FFRDC studies. In effect, FFRDCs had some of the characteristics of a super technocracy--a technocracy's technocracy--that could exercise a degree of control over the fortunes of organizations in the ordinary technocracies. It is not surprising, therefore, that congressional interest in FFRDCs was piqued, in part, by companies who resented working under the close technical direction of certain FFRDCs.[26]

FRAMING THE ISSUE

The political debate over DOD's FFRDCs had some positive effects. From a public policy perspective it helped focus the advantages and disadvantages of FFRDCs as performers of R&D. A study funded by NSF and conducted by the University of Denver Research Institute was particularly useful.[27] It identified several advantages and disadvantages to government use of FFRDCs, all of which (plus others) are still relevant today:

Advantages

1. **Relative ease, when compared to government agencies, in attracting and retaining high-quality staff members.** Under current civil service rules, the government still has problems attracting the quantity and quality of scientists and engineers it requires.[28]

2. **High objectivity of R&D output.** Those who hold this view note that FFRDCs are organizationally separate, receive fairly constant funding and, do not usually compete for the work they receive.

3. **High quality of R&D work.** This claim is disputed by some industrial performers, but the often spectacular successes of FFRDCs--such as RAND in systems analysis and JPL in interplanetary exploration--are well documented.

4. **Freedom from conflicts of interest to which industrial performers of R&D are susceptible.** Conflicts of interest (COIs) are often related to competition and the profit motive; e.g., a firm competing for a cost-type contract may give a biased projection of the cost and technical feasibility of a project. But FFRDCs can also become embroiled in COIs; e.g., if they become too interested in growth, or acquiesce too readily to improper sponsor demands.

5. **Freedom to concentrate on work assigned by their sponsors without wasting resources on competing for new work.** This recognizes that competition is not free. Performers who compete for government work typically have large, expensive marketing and proposal staffs.

6. **Intimate familiarity with sponsor activities and needs.** This is based on the

FFRDC's "special relationship" with its sponsor, allowing quick and thorough dispersion of plans and technology between sponsor and FFRDC.

7. **Broad communication of R&D results.** FFRDC mandates to disperse new technology throughout the industrial community have been aided by recent federal legislation, including the National Competitiveness Technology Transfer Act.[29]

8. **Excellent interdisciplinary capability.** FFRDCs can organize around and concentrate on well-defined tasks over long periods of time. Performers who are constantly winning and losing jobs find it more difficult to maintain interdisciplinary teams.

9. **Quick response to the sponsor's needs.** This is due to the FFRDC's close relationship with the sponsor, exemption from competition, and freedom from federal regulations that slow down response times.

Disadvantages

1. **High costs relative to other performers because of their nonprofit status and exemption from competition.** It is difficult to compare the efficiency of FFRDCs with commercial performers because cost-effectiveness measures are not comparable across programs. One study conducted by individuals from private industry found no significant difference in the cost structures of FFRDCs and industry. The same study concluded that the fees paid to DOD FFRDCs were about one-half those paid to commercial performers.[30]

2. **Usurping the Government's policy functions by exercising undue influence on the policy-making process.** This criticism is usually leveled by elements within Congress, although what constitutes "undue influence" varies from person to person.

3. **Adverse effects on federal in-house competence due to FFRDCs performing the most challenging work.** There may be merit to this view, but the agency sponsor typically chooses which work the FFRDC receives.

4. **Absence of sufficient discipline to stimulate high levels of performance due to exemption from competition.** This would be hard to justify given the numerous, well publicized successes of FFRDCs.

5. **Unfair advantage in obtaining R&D work due to exemption from competition.** Commercial performers view this as a valid criticism. But from the viewpoint of agency sponsors it is not obvious that the exemption has been a bad thing.

6. **R&D output biased toward sponsor's viewpoint.** Critics of FFRDCs charge that "he who pays the piper calls the tune" and that FFRDCs serve the interests of their sponsors rather than the public. Many also believe that profit-making research organizations have less reason than FFRDCs to be biased.[31]

Another disadvantage aired during the late-1960s-early-1970s debate and which is still claimed today, is that FFRDCs have out-lived their usefulness. Critics point out that FFRDCs were created in the crisis atmosphere of World War II and the Cold War when quick reaction to perceived threats was essential. It was prudent to concentrate resources in FFRDCs to focus energies on defense-related science and technology tasks. Now, the critics say, private industry is capable of performing most R&D tasks performed by FFRDCs. The government, therefore, should acquire more R&D from industry in keeping with its traditional reliance on the private sector.

ECONOMICS, POLITICS, AND INSTITUTIONAL DESIGN

Did the lack of public debate on FFRDCs in the 1940s cause the criticisms of the late 1960s and early 1970s? Certainly many concerns raised by the critics are the type that would have been addressed during an earlier debate. But given the fundamental economic and political implications of the issues raised, it is probably more accurate to say that the lack of earlier debate merely delayed the surfacing of the criticisms. Bruce Smith and Joseph Karlesky have noted that the competition for research funds among the various performers became more intense as federal R&D expenditures leveled off in the late 1960s.[32] Such competition in all likelihood fueled the criticism of FFRDCs. Other elements of the debate lead one to suspect institutional design as another explanation.

Clearly, there is substantial disagreement

over whether certain FFRDC attributes should be considered advantages or disadvantages, depending on one's institutional partiality. But institutional attributes are a product of institutional design. The institutional design of FFRDCs is, I think, a major cause of conflict with commercial performers of R&D and with Congress. This can be better understood when one recognizes that actors in the science and technology policy arena operate from different paradigms and therefore use different conceptual strategies to justify government action. Harvey Averch's models of science and technology policy justification are useful in helping to understand these differences.[33] Two models in particular--the engineering and market models--provide insight into how proponents of different strategies are likely to view institutional performers of R&D.

Proponents of the engineering model view the government as having primary responsibility for solving major social and economic problems. Hence, the government has an interest in guiding R&D and assuring appropriate levels of funding to alleviate such problems. The government, having greater access than the market to information about the future consequences of R&D, must actively promote technology. The market contains institutional barriers preventing correct, long-term assessments of R&D. Direct action by the government is superior to indirect action because the government can better control its own activities and can design effective programs.[34]

From this description of Averch's engineering model it is clear that the type of institution performing R&D should matter to engineering advocates. They should tend to prefer government laboratories, and private industry should usually be their last choice. FFRDCs should fall some place in the middle because they have some government and some private attributes. While FFRDCs are tied closely to the goals and programs of their sponsoring agencies and do not have the conflicts of interest associated with private industry, they are private entities and they do have certain freedoms of action that proponents of the engineering model would find uncomfortable.

In the late 1960s and early 1970s as well as today, proponents of the engineering model can be seen in Congress and the bureaucracy. They are suspicious of FFRDCs because their institutional design enables them to "circumvent" civil service and procurement regulations and because their views receive great deference in agency policy making.

But FFRDCs do not really circumvent civil service rules; the rules are simply inapplicable to private performers. Instead FFRDCs typically pay market wages and salaries that bear a strong relationship to the wages and salaries paid by their parent organizations. As noted above, to the extent FFRDCs have exceeded civil service pay scales, the government has benefitted by receiving the services of scientists and engineers it could not have obtained otherwise.

In the procurement arena FFRDCs are exempt from some regulations that are applicable to other contractors. The exceptions, however, are in recognition of the FFRDC's status as a full member of the sponsoring agency's team, which by design is different from the arms length relationship agencies have with profit-making contractors. Also, such exceptions allow FFRDCs to conduct procurements two or three times faster than federal agencies--an ability that is often essential to the successful completion of agency missions. While exceptions to procurement regulations have been granted, most FFRDCs conduct their procurements according to the federal model, including the requirement to obtain competition when practicable.[35]

It is difficult to understand the concern--coming primarily from members of Congress--over the influence FFRDCs have in the policy-making arena. First, agencies are free to disregard or modify FFRDC advice (which they often do). Second, agencies receive advice from a variety of outside sources, including universities, commercial performers, members of Congress, and various special interest groups. Why discriminate against FFRDCs, which may be in the best position to provide objective advice on the science and technology policy issues facing their agency sponsors?

Proponents of Averch's market model believe market incentives and the price system

should be the principal means of delivering goods and services. However, society underinvests in R&D because the market for R&D is affected by high risks and externalities. Government programs to correct this situation should be limited primarily to support for basic research, because this phase of R&D suffers most from market failure. Direct government activity in the later phases of R&D should be limited because the market is more effective. Government policies, programs, and regulations are barriers to efficient R&D.[36]

Thus, the type of institution performing R&D should also matter to advocates of the market model. They should favor private industry as the primary performer of R&D. They should also view government performance of R&D as an improper encroachment on the market. As with proponents of the engineering model, market advocates should have mixed feelings about FFRDCs but for the opposite reasons. They should be uncomfortable with the close ties FFRDCs have to the goals and programs of their sponsoring agencies and with their exemption from competition. On the other hand proponents of the market model should be comforted by the private nature of FFRDCs and the freedom of action that could make them more efficient than government laboratories.

In fact, private industry does view FFRDCs with suspicion because their institutional design exempts them from competition and other principles of the market model. In the early 1970s, the National Council of Professional Service Firms issued a statement calling for maximum reliance on qualified for-profit performers and a limited role for DOD's FFRDCs: "The fundamental policy which should guide support of captive organizations such as FCRCs [i.e., FFRDCs] is to limit their activities to those for which the private sector has no competence or no existing capability. Where there exists no capability in the private sector and the government needs a service performed, this service may be performed in-house or through an FCRC initially, but at the same time, steps should be taken to encourage the private sector to develop such capability . . . at the earliest possible time."[37]

Many in industry have proposed that FFRDCs be required to compete for their share of the federal R&D dollar. However, as the General Accounting Office has noted, this would alter the nature of an FFRDC's special relationship with its sponsor by subjecting the FFRDC to the uncertainties of the market place.[38] If FFRDCs had to compete they would be more concerned about obtaining new business than providing unbiased advice to sponsors. Because FFRDCs are defined in terms of such a relationship, acceptance of this idea would be tantamount to abolishing FFRDCs as an alternative way of meeting government R&D needs.

NEW RULES AND THE CONTINUING QUEST FOR LEGITIMACY

In 1972 the U.S. Commission on Government Procurement (COGP) issued a study report on the federal procurement process which recommended that the government keep open the option of using FFRDCs to satisfy "needs that cannot be satisfied effectively by other organizational resources."[39] In response, the Office of Federal Procurement Policy (OFPP) issued a policy statement on FFRDCs that is still applicable to all government agencies.[40] The statement, which superceded the 1967 criteria promulgated by the Federal Council for Science and Technology, governs the establishment, use, periodic review, and termination of FFRDCs. It provides that, in establishing FFRDCs, the sponsoring agency must ensure that (1) existing sources cannot effectively meet the special R&D needs of the agency, (2) public notices be published indicating the agency's intention to sponsor an FFRDC, (3) costs of FFRDC services provided to the government are reasonable, and (4) the FFRDC's stated mission clearly indicates the kind of work it will perform.

These constraints on establishing FFRDCs are clearly intended to quell the objections from Congress and industry that were raised in the late 1960s and early 1970s concerning the over-use of centers. But the policy statement goes farther, prohibiting FFRDCs from competing with any non-FFRDC "in response to a federal agency formal Request for Proposal for other than the operation of an FFRDC."[41]

The statement has given FFRDCs a degree of legitimacy among institutions that perform government R&D. It recognizes the unique institutional character of FFRDCs by acknowledging that they must have access "beyond that which is common to the normal contractual relationship,"[42] to government and supplier data, employees, and facilities needed to discharge their responsibilities, even if that data is sensitive or proprietary. The statement also recognizes that FFRDCs should not be subject to the same market-oriented rules governing activities of profit-making contractors. It requires sponsors to "undertake the responsibility to assure a reasonable continuity in the level of support to the activity [i.e., FFRDC] consistent with the agency's need for the activity and the terms of the sponsoring agreement."[43]

FUTURE PROSPECTS

In the last few years the number of FFRDCs has again increased. The current official list of centers from the NSF includes 41.[44] DOE operates 22, DOD has 11 and the remaining 8 are spread among NASA, NSF, the Department of Health and Human Services, and the Nuclear Regulatory Commission. The increasing numbers of FFRDCs and reduced defense budgets has led to renewed complaints from Congress and industry about the amount of federal funding that goes to centers. Led by the Professional Services Council (formerly the National Council of Professional Service Firms) and the U.S. Chamber of Commerce, industry has again pointed to the exemption of FFRDCs from competition.

But some in Congress see an expanding role for FFRDCs. Through the National Competitiveness Technology Transfer Act of 1989, FFRDCs have the legislative authority to enter into cooperative R&D agreements with private industry.[45] DOE centers are particularly interested in taking advantage of this new authority in light of massive funding cuts for nuclear weapons research. If technology transfer from the public sector to the private sector is successful, FFRDCs could become a force in improving America's competitiveness in international markets.

The down-sizing of the defense establishment presents other possibilities. In particular, the conversion of certain R&D functions performed by government in-house laboratories and private industry to the FFRDC model warrants further study. The Augustine Committee briefly discussed the conversion of government labs to FFRDC status in their report on the future of the U.S. space program. Commenting on the NASA/Caltech arrangement for the management of the Jet Propulsion Laboratory, the Committee stated that it had "provided an enormously effective means of obtaining needed technical expertise unfettered by the adverse civil service restrictions."[46] It recommended that NASA selectively phase additional centers into the JPL model by affiliating them with universities as FFRDCs.[47]

The conversion of segments of the defense industry to FFRDC status could allow for the orderly reduction of excess capacity that currently exists at the major systems contractor level. For example, segments of the seven contractors currently capable of producing air frames might be rationalized to three or four FFRDCs--enough to eliminate excess capacity but still maintain an element of competition. This would <u>not</u> mean that all work for major aircraft systems would be performed in-house by FFRDCs. Instead, the FFRDCs would perform as R&D centers responsible for systems integration, with most of the work subcontracted to private industry. This would require an arms length relationship between the FFRDC and its parent and might require the parent to divest itself of certain operations to avoid organizational conflicts of interest.

The greatest economies would probably occur in situations where government laboratories and private enterprises are combined into a single FFRDC. This would allow close coordination among the processes associated with requirements determination, design, development, and systems management. Not only would redundancies be eliminated, but time-consuming and costly competitions and contractual disputes would be greatly reduced.

This proposal would <u>not</u> do away with the defense industry and would <u>not</u> amount to nationalization. It would convert appropriate

parts of the industry's top layer--major systems contractors--to quasi private (or public) FFRDCs. The remainder of the industry would remain in tact, perhaps supplemented by operations spun off by companies selected to become FFRDCs.

Others will argue that the concept violates the government's long-standing policy of favoring private enterprise in the procurement of goods and services. But to what extent is the top level of the defense industry truly "private enterprise"? If we judge it on the basis of its adherence to free market principles, it falls short on the "private" side as well as the "enterprise" side. As Don Price pointed out almost 30 years ago, the relationship between the government and business for the planning and conduct of R&D programs "is more like the administrative relationship between an industrial corporation and its subsidiary than the traditional relationship of buyer and seller in a free market."[48] (This already sounds a lot like the relationship between the government and an FFRDC.)

Price went on to note that even the contractual relationship "is not the traditional market affair."[49] Contracts are not awarded on the basis of competitive bids; sometimes they are not competed at all. The contractor does not earn a profit in the marketplace, but is given a fee after all its allowable and allocable costs are paid for by the government. The end product cannot be specified in any detail, so the processes and procedures used by the contractor to achieve an end product are specified by the government. The government supplies much of the plant and capital, and has a say in which costs it pays. The government even dictates how contractors account for costs.

These distortions point to the conclusion that the market relationship between the government and its major contractors is a weak one at best. Unlike the traditional market relationship in which there are many buyers and sellers, the marketplace for government contractors is characterized by one buyer (the government) and many sellers (the contractors). Thus, the normal give and take that occurs in a free market does not work as well.

CONCLUSION

The first step in helping people understand the nature and proper role of FFRDCs should be to better define them. The NSF criteria for FFRDCs are inadequate. At a minimum, criterion 5 should be revised as follows: "It has a long-term relationship with its sponsoring agency as evidenced by (1) relative stability in the level of work it performs for the agency, and (2) special access to information concerning agency plans and programs." In addition, criteria 2, 3 and 6 should be eliminated as they add nothing meaningful to the definition.[50]

The top level of the defense industry (which to some extent is the top level of the space and nuclear energy industries) is closer to the FFRDC model than many would like to admit. Converting these contractors, and certain government labs, officially to FFRDCs would no doubt create problems. Issues associated with stockholder equity, intellectual property rights, and organizational conflicts of interest, to name a few, would have to be dealt with. From a political point of view, opposition would come not only from those who see FFRDCs as too much like government agencies, but from those who believe they are too much like private companies. However, now is the time to explore this possibility. With the end of the Cold War, effective rationalization of the defense establishment is crucial to ensuring America's place as a major power in the 21st century. Greater use of the FFRDC model should be studied as part of the rationalization process.

Conflicts over the proper role of FFRDCs will never subside completely. But then conflicts over the proper role of the other institutional performers of federal R&D have never totally subsided either. FFRDCs are a distinctive and useful addition to the array of R&D performers available to the government. As long as government is obliged to focus on day-to-day operations and the competing demands of our pluralistic society, an incremental approach to public policy is probably inevitable. Policy makers will have

very little time or inclination to plan creatively for America's science and technology future. The independent, interdisciplinary nature of FFRDCs allows for the development and consideration of policy alternatives that otherwise might not be advocated as forcefully. This paper suggests that other performers may often lack the capacity, objectivity, or desire to perform this function.

FFRDCs remain an effective way for government to attract the quantity and quality of scientists and engineers it needs. Their insulation from conflicts of interest is not perfect, but is more nearly so than with commercial performers. In short, FFRDCs provide government with an institutional compromise that utilizes the efficiencies and inducements available through private sector means, while assuring a high degree of loyalty and dedication to public ends.

NOTES

1. Robert P. Crease and Nicholas P. Samios, "Managing the Unmanageable," The Atlantic, 267 (1/91): 80.
2. Lee A. DuBridge, "Science and Government," Chemical and Engineering News, 31 (4/6/53): 1384.
3. NSF, Division of Science Resources Studies, Federal Funds For Research and Development: Fiscal Years 1989, 1990 and 1991, XXXIX (Washington, D.C.: NSF, 1990): 10.
4. Ibid., 11.
5. OSRD was established by in 1941 and headed by Vannevar Bush. It supported R&D in several areas during World War II, but departed from earlier science agencies by not operating laboratories. OSRD's main R&D tool was contracts with industry and academia.
6. Defense Science Board, Report of the Defense Science Board Task Force on Federal Contract Research Center Utilization (Springfield, VA: National Technical Information Service, 2/76): 8.
7. Clayton R. Koppes, JPL and the American Space Program (New Haven, CT: Yale University Press, 1982).
8. Def. Science Board, 9.
9. Harold Orlans, Contracting for Atoms (Westport, CT: Greenwood Press, 1967): 4-8.
10. Ibid.
11. John Walsh, "RAND: R&D Nonprofit Pioneered a New Kind of Organization, Served as a Model for Others," Science, 144 (5/29/64): 1113.
12. Ibid.
13. Ibid.
14. Subcommittee report from 1959, quoted in Walsh, 1113.
15. Report of the Commission on Government Procurement, 1 (Washington, D.C., 1972): 17.
16. Harold Orlans, The Non-profit Research Institute: Its Origin, Operation, Problems, and Prospects (New York: McGraw-Hill Book Co., 1972): 130.
17. U.S. Bureau of the Budget, Report to the President on Government Contracting for Research and Development (1962), quoted in GAO report, Issues on Establishing and Using Federally Funded Research and Development Centers, GAO/NSIAD-88-22 (Washington, D.C., 1988): 10.
18. Funding for these FFRDCs was discontinued in FY 1979.
19. Commission on Government Procurement, 16.
20. Frank Fischer, Technocracy and the Politics of Expertise (Newbury Park: Sage Publication, 1990): 17.
21. House Committee on Appropriations, DOD Appropriation Bill, 1972, House Report 92-666, 92nd Congress, 1st session, 1971, 106-121, cited by Commission on Government Procurement, 18.
22. Congressional Research Service, The Strategic Defense Initiative Institute: An Assessment of DOD's Current Proposal (Washington, D.C., 1986): 5.
23. Following these reductions, the number of FFRDCs remained fairly constant for several years and totalled 34 in 1984.
24. NSF, Division of Science Resources Studies, Federal Funds for R&D: Detailed Historical Tables: FY 1955-1985, (Washington, D.C., 1984): 115-118; and NSF, 1990, unnumbered page. (See also Senate Governmental Affairs Subcommittee on Oversight of Government Management, "Inadequate Federal Oversight of FFRDCs," 7/8/92.

This report indicates NSF dollar figures for FFRDCs may be understated by as much as 37%.)

25. Def. Science Board, 11.

26. Dean C. Coddington and J. Gordon Milliken, "Future of Federal Contract Research Centers," Harvard Business Review (March-April 1970): 106.

27. Ibid.

28. Report of the Advisory Committee on the Future of the U.S. Space Program, Norman Augustine, Chairman, (Washington, D.C., 1990): 46.

29. Public Law 101-189, the National Competitiveness Technology Transfer Act of 1989, amended the Stevenson-Wydler Act (Public Law 96-480) to allow FFRDCs to enter into cooperative R&D agreements.

30. Def. Science Board, 23-24.

31. Orlans (1972), 86-90.

32. Bruce L.R. Smith and Joseph J. Karlesky, The State of Academic Science: The Universities in the Nation's Research Effort (New York: Change Magazine Press, 1977): 52.

33. Harvey A. Averch, A Strategic Analysis of Science and Technology (Baltimore: Johns Hopkins University Press, 1985).

34. Ibid., 47-48.

35. Federal Acquisition Regulation 6.101 references two statutes (10 U.S.C. 2304 and 41 U.S.C. 253) that require government contracting officers to "promote and provide for full and open competition in soliciting offers andawarding Government contracts." Because many FFRDCs consider themselves part of their sponsor's family, and place a premium on objectivity, they have adopted policies on competition similar to the government's.

36. Averch, 48-49.

37. Def. Science Board, 9.

38. GAO, 22.

39. Commission on Government Procurement, 16.

40. Office of Federal Procurement Policy, Federally Funded Research and Development Centers, OFPP Policy Letter 84-1 (Washington, D.C., 1984).

41. Ibid., 5.

42. Ibid., 3.

43. Ibid.

44. Unpublished list obtained from NSF, Division of Science Resources Studies, Washington, D.C., 1992.

45. Congressional Research Service, Federally Funded Research: Decisions for a Decade (Washington, D.C., 1991): 261.

46. Augustine Committee, 46.

47. Ibid.

48. Don K. Price, The Scientific Estate (Cambridge: Harvard University Press, 1965): 37.

49. Ibid., 38.

50. At least one FFRDC, the Aerospace Corporation, owns most of its facilities.

Perspectives on the Use of Modeling & Simulation (M&S) in the Acquisition Process

Dr. Joel M. Schoen
Dr. Stuart H. Starr
The MITRE Corporation

Abstract

Recently, there has been renewed interest in employing modeling and simulation (M&S) to enhance the effectiveness and efficiency of the acquisition process. This interest has been manifested in recent concepts such as *synthetic environments* and *virtual prototyping* which are designed to take advantage of the burgeoning technology supporting M&S.

Over the past thirty years, the MITRE Corporation has made extensive use of M&S to support a broad spectrum of acquisition programs. These acquisitions typically involve complex information systems for both the military community and civil agencies. In an effort to distill M&S lessons learned from these experiences, a number of in-depth case studies have been performed. By integrating across those case studies, a set of key issues has been identified that are perceived as being central to the effective use of M&S in the acquisition process. These issues involve challenges associated with the effective creation of credible M&S, the effective sharing of M&S within and across community lines, the development of efficient methodologies to govern the use of M&S, and the injection of new technology into evolving M&S. For selected issues, the results of the case studies are used to derive findings on the use of M&S in the acquisition process. The paper concludes by formulating a set of recommendations in the areas of policy, management, standards, and technology that should serve to enhance the effective application of M&S in the evolving acquisition process.

I. Introduction

Throughout the government sector, fundamental changes are underway in the processes by which complex systems are acquired. These changes are being driven by the confluence of several factors: resource constraints (e.g., reductions in available resources due to the burgeoning national debt); opportunities offered by commercial products; and new acquisition paradigms (e.g., increased emphasis on advanced technology demonstrations). These factors have stimulated renewed interest in using M&S creatively to enhance the acquisition of complex systems.

For example, DoD has recently established the Defense Modeling and Simulation Office (DMSO) to help stimulate the development of the infrastructure required by the users of M&S. In a related action, the Director, Defense Research & Engineering (DDR&E) has initiated a set of Science & Technology thrusts [1]. Prominent among these thrusts is an effort to stimulate the development of "synthetic environments." These environments envision the possible interaction of a variety of M&S, including operations with real equipment in the field (*live*); war games, models, and analytical tools (*constructive*); and systems and troops in simulators fighting on simulated battlefields (*virtual*).

Similarly, civilian government organizations are seeking enhanced M&S to facilitate the acquisition of complex systems. For example, the Federal Aviation Administration (FAA) is exploring the de

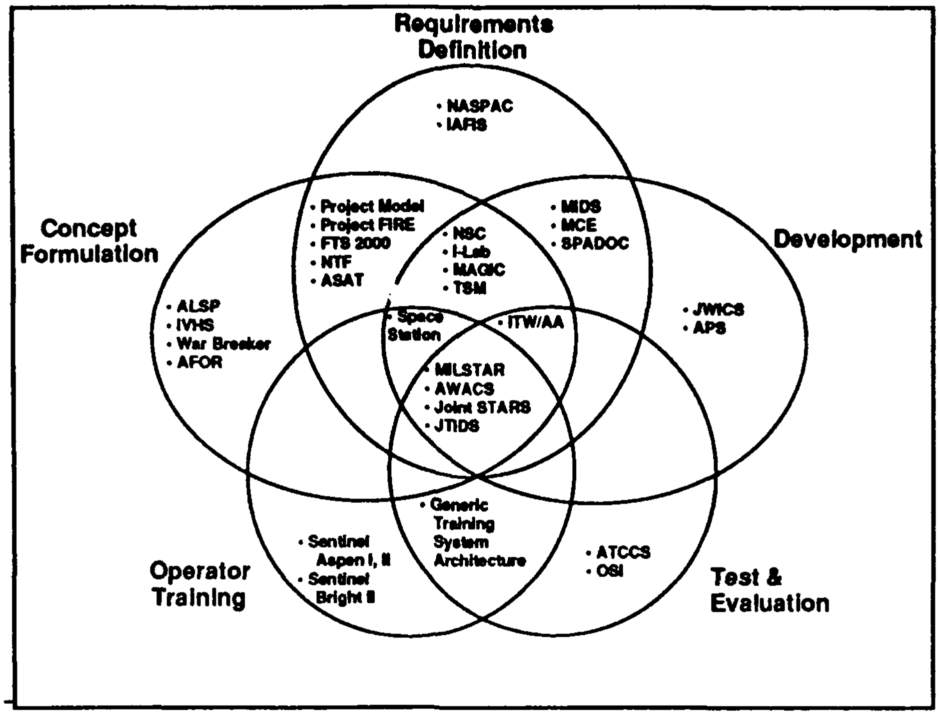


Figure 1 Selected MITRE Experiences

Table 1 M&S Projects Considered in the Case Studies

Type	Acronym	Project
Communications — Systems	JTIDS	Joint Tactical Information Distribution System
	MIDS	Multifunction Information Distribution System
	MILSTAR	Military Satellite Communications System
Communications — Networks	FTS 2000	Federal Telecommunications System 2000
	JWICS	Joint Worldwide Intelligence Communications System
	MAGIC	Multidimensional Applications Gigabet Internet Consortium
Command & Control Systems	ATCCS	Army Tactical Command and Control System
	IVHS	Intelligent Vehicle/Highway System
	ITW/AA	Integrated Tactical Warning/Attack Assessment
	MCE	Modular Control Element
	SPADOC	Space Defense Operations Center
Information System Support	APS	Automated Patent System
	IAFIS	Integrated Automated Fingerprint Identification System
	TSM	Tax Modernization System
Sensors/C^2 Nodes	AWACS	Airborne Warning and Control System
	Joint STARS	Joint Surveillance & Target Attack Radar System
Intelligence		Sentinel Aspen I, II
		Sentinel Bright II
Infrastructure — General	OSI	Open System Interface
		Space Station
Infrastructure — M&S	AFOR	Automated Forces
	ALSP	Aggregate Level Simulation Protocol
	I-Lab	Integration and Interoperability Laboratory
	NASPAC	National Airspace System Performance Analysis Capability
	NSC	National Simulation Center
	NTF	National Test Facility
		Warbreaker
		Project Model
	Project FIRE	Project Facility for In-place Realistic Emulation

velopment of a National Simulation Capability to support the design and development of the next generation air traffic control system.

This paper was developed to share the insights that MITRE, a Federally Funded Research and Development Center (FFRDC), has acquired in applying M&S to the acquisition of complex systems. To realize that goal, four inter-related objectives have been identified. First, the paper highlights the benefits that can be obtained from the appropriate use of M&S in acquiring complex systems. Examples are cited of the benefits that have been derived. Second, the paper identifies and discusses critical issue areas that practitioners of M&S must confront. For selected issue areas, significant findings are derived. Finally, the paper formulates recommended courses of action for the community to undertake to resolve residual issues.

This paper focuses on experiences in applying M&S to the system acquisition process. For the purposes of this paper, system acquisition is subdivided into five phases: concept formulation, requirements definition, development, test and evaluation, and operator training. Examples will be given of M&S experiences that fall within and across these categories. In addition, consideration will be given to operations & maintenance (O&M) because of the emphasis of concurrent engineering in system development.

The bulk of the acquisition work treated in this study is concerned with command and control systems, both for military and civilian clients. Accordingly, the paper emphasizes the lessons learned from applying M&S to a broad spectrum of command and control systems. However, the case studies have also included systems to deal with environmental issues (e.g., chemical demilitarization), space (e.g., space station), and telecommunications (e.g., the Federal Telecommunications System 2000). Consequently, those activities have been considered in the identification and analysis of M&S issues.

II. Study Approach

This study is based upon recent experiences in support of systems acquisitions in both the military and civil sectors. The issues, findings, and recommendations were developed by reviewing the results of M&S activities across the company and integrating the observations from individual activities. This included reviewing key studies and conducting focus group discussions to elicit lessons learned.

These experiences in M&S support of acquisition can be related to specific phases in the acquisition cycle. In Figure 1, selected projects with significant M&S content have been mapped onto the *concept exploration*, *requirements definition*, *development*, *test and evaluation*, and *operator training* phases of the acquisition process. In general, M&S work in support of these projects transcends a single phase. This is illustrated by the use of overlapping regions on this figure.

The projects included in this study span a wide range of types: communications (systems and networks), command and control systems, information system support, sensors/C^2 nodes, intelligence, and infrastructure (general and M&S). Table 1 maps the projects of interest into these categories. Technical characterizations of these projects can be found in [2].

III. Major Benefits

The general benefits of M&S are outlined in Table 2 for each phase of the system life cycle from concept exploration and system advocacy, through test and evaluation and operator training. The following discussion briefly cites examples of the benefits that have been derived from specific programs.

In support of *system advocacy* activities, M&S-based analysis can provide answers to technical questions posed by decision makers. In the case of the Airborne Warning and Control System (AWACS), M&S was used to demonstrate system performance in the presence of jamming and screening. Similarly, the Joint Surveillance and Target Attack Radar System (Joint STARS) Radar

Table 2 Major Benefits of M&S in the Acquisition Process

Activity	Benefits
System advocacy	• Address issues posed by decision makers
Concept exploration	• New insights into system or process and its integrated operation in its environment
Requirements formulation	• Clear translation of users' needs to a well-defined set of technical requirements • Evaluation of cost, schedule, and effectiveness
Development	• Reduction of cost and risks associated with design and integration • A process to verify design
Test and Evaluation	• Efficient and cost-effective planning and extension of test and evaluation • Identification/understanding of critical system parameters
Operator Training	• Reduced lifecycle cost for training • Better trained operators

Evaluation Activity (REA) model was used to demonstrate system effectiveness in the presence of terrain screening. If satisfactory answers to the questions had not been found, it is likely that these projects would have been canceled.

The Joint STARS REA model was also very important in *concept exploration* activities. Joint STARS represented a new mission exploiting new technology. The REA was also used to check out the effectiveness of human-system interface concepts such as the use of compressed history displays as a human-in-the-loop tracking technique. Due in large measure to the contribution of M&S, two developmental models of Joint STARS were deployed successfully in operation Desert Storm, six years before they were to achieve Initial Operational Capability. In the Modular Control Element (MCE) Project, M&S was used to prove that frequency-agile filters were not necessary to prevent interference between four HAVE QUICK radios operating in the same shelter. An unnecessary $30M procurement was thereby terminated.

M&S can be used to explore alternative system concepts with significant impact on system cost. For example, in the Seek Igloo AN/FPS-117 radar development, M&S played a major role in system upgrades designed to reduce operations and maintenance costs. The original system performance specification was used, but new operations concepts were explored. Simulation of the required frequency spectrum of the radar signals to meet the system mission demonstrated the feasibility of solid-state components. The resultant upgrade does not require operators on-site. It employs a highly redundant solid-state design and remotes the radar data to a Regional Operational Control Center (ROCC). The resulting operations and maintenance budget has been reduced by 60% (from $120M to $49M in FY91). In addition, staffing was reduced from 1650 to 270. The return on investment of this upgrade is 22% over five years.

M&S can play a vital role in the *development of consistent requirements* that can be traced back to the system operational concepts. In the Multifunctional Information Distribution System (MIDS) development, VHDL (VHSIC Hardware Description Language) simulation of application specific integrated circuits uncovered specification inconsistencies that would have required an estimated $2.6M rework . Since the MIDS development is a multinational effort, it is very likely that the problems would have been magnified as information was transferred from country to country. In the area of chemical demilitarization, i.e., the destruction of chemical weapons stockpiles, M&S was used to evaluate the comparative performance and cost of demilitarization plant alternatives, analyze the throughput of a plant so that the number of facilities could be scoped, and evaluate risk and cost of munition transport alternatives.

During system *development*, it is difficult to monitor design convergence toward the overall system requirements. M&S can be employed effectively to ascertain if the design activity remains on track. During the Joint STARS development, for example, REA-based analysis identified problems with the data processor capacity that the contractor was planning to employ. As a result of this analysis, two successive changes in the number of processors and their processing capability have been made.

M&S support to *test and evaluation (T&E)* can be significant in planning tests, interpreting data, training operators for the tests, and actually providing part of the test environment. In the Joint Tactical Information Distribution System (JTIDS) project, a terminal simulation was developed to serve as a real-time monitor of network performance, halting tests when malfunctions or errors occurred. Simulations reproduced test deficiencies to identify test extensions to improve test efficiency. An F-15 manned simulator was used to train pilots for actual flight tests as well as to augment flight test results.

The use of M&S to support *operator training* over and above that required for test and evaluation has been demonstrated in a number of projects. In Sentinel Aspen I and II, and Sentinel Bright II intelligence systems, model-based training resulted in better trained operators and reduced life cycle costs for training. Moreover, model-based training can be reconfigured to train operators rapidly for system upgrades. Training modules were also developed for MILSTAR military satellite communications system operators to illustrate the impact of satellite orbits on earth area coverage.

When properly employed, M&S can serve as a tool to optimize the cost of development and ownership of a system. It is typically this objective that drives the use of M&S in support of system acquisition, training, operations, and maintenance. Yet there is another issue associated with the development of system models. Experience indicates that the development and maintenance of complex system-of-system architectures must be supported by the availability of an infrastructure of interoperating, verified, validated, and accredited (VV&A'ed) models. The requirements for model compatibility with the infrastructure are not driven by the individual system developer, but must be developed and enforced by the organization responsible for the infrastructure. Thus, the effective use of M&S to support acquisition must be viewed not only in the context of optimizing the development and cost of ownership of the specific system, but also in the context of analysis of the interoperability and effectiveness of the system interacting with other systems and humans when exposed to various environments and threats. The issue of *M&S Infrastructure* addresses the problem of how best to develop the tools necessary to support system-of-system evaluation.

A single system model cannot satisfy all potential uses outlined here. It is necessary to envision a group of related models each addressing a specific problem area. The discussion of the *Evolution of M&S throughout the Acquisition Cycle* addresses the relationship of models used at different stages of the acquisition process.

IV. Key Issues, Findings, & Recommendations

In analyzing the individual issues that emerged from prior experiences, it became apparent that they could be embedded into four macro, interrelated issue areas: *M&S creation, M&S use, tools, and data.* The relationship among these areas is illustrated in Figure 2.

In the area of *M&S creation*, four issues were identified: the technology needed to support the creation of M&S; the strategy that should be used in developing models; the evolution of M&S through the acquisition cycle; and the VV&A of M&S. In the area of *M&S use*, three issues were identified: the community sharing of M&S; the Systematic Use of M&S, the role of virtual prototyping in the acquisition process. The strategy that should be used in developing the M&S infrastructure to meet the needs of the acquisition community emerged as the key tools issue. Finally, the activities re-

quired to satisfy the acquisition community's data needs was identified as the paramount data issue.

In this paper a selection of the issues are discussed in detail. These include Evolution of M&S Through the Acquisition Cycle, VV&A, Community Sharing of M&S, the Systematic Use of M&S, the Role of Virtual Prototyping in the Acquisition Process, M&S Tools, and Data Needs. The summary includes a synopsis of the findings and recommendations of all the issues considered in this study.

A. M&S Creation

Issue: Evolution of M&S Through the Acquisition Cycle DoD is drafting an M&S policy that requires the use of models and simulations at each major milestone in the acquisition process. The relationship of the models at one step in the acquisition process to those at another step is currently not defined. On the basis of cost considerations alone, one should promote model reuse and refinement as the system development process advances. However, experience with the use of M&S throughout the system life cycle suggests that model reuse has quantifiable benefits only at certain points in the system life cycle. At other points, independent model development should be exploited. Moreover, legal restrictions prohibit the use of contractor models for Operational Test and Evaluation (OT&E).

M&S is an application-driven endeavor. As such, the model developed at one stage of the acquisition process may have been designed to provide answers to a different range of questions than must be investigated at another stage of the acquisition process. Care must therefore be exercised in the use of models developed at a different stage of the acquisition process. Alternatively, consideration must be given during model development to the possible uses of the model at later stages. Modular development of the model to provide a simple means of enhancing the model capabilities to meet later requirements should be pursued. It is also mandatory that models be adequately VV&A'ed prior to their use at later stages in the acquisition process.

It has been found that the development of a system model is one of the best ways to gain insight into the operation and requirements for the system. It is therefore recommended that government-developed models **not** be used directly by the contractor for system development. It is much more beneficial for the contractor to develop a separate evolutionary set of models. The models should be developed by a closely-knit team of the model and system developers, because when the coupling between the models and system developers is not adequately close, the resulting models are found to be of low

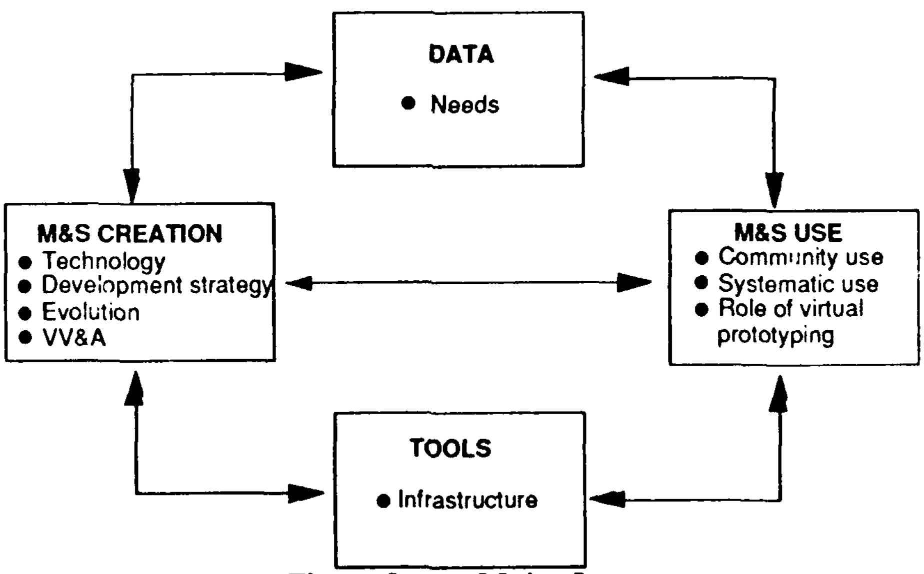


Figure 2 Major Issues

fidelity, incorrect or misguided.

Consequently, one can envision two sets of evolutionary models: a government set describing system requirements and environment, and a contractor set dealing with system implementation. The two model sets should be correlated, but should be independent. Moreover, the contractor models should be deliverables. A number of benefits result from requiring the contractor to deliver development models to the government. These include better insight by the government into how well the design is converging on the requirements, better evaluation of the impact of engineering change proposals, and more accurate forecasting of how the system performance will improve with maturing technology.

Issue: VV&A There is increasing awareness in the M&S community of the need to perform VV&A. However, there is no agreement on the paradigm that should be applied in performing those functions. As a consequence, there is little appreciation of the resources (e.g., cost, time) that should be allocated to the VV&A of M&S, as a function of its size and complexity.

In recent years, the Military Operations Research Society (MORS) has undertaken several initiatives on the subject of VV&A. In the late 1980's, it established a Simulation Evaluation Methodology Technical Group (SEMTG) to formulate a high level concept for establishing confidence in the output from M&S [3]. More recently, MORS has convened several Simulation Validation (SIMVAL) workshops [4]. Through those workshops, the community is converging on definitions of the terms verification, validation, and accreditation, and establishing preliminary agreement on alternative levels of VV&A (e.g., face, constructive, predictive).

Based upon prior experiences with the VV&A process, several key insights have emerged:

1. It has become apparent that VV&A must be begun at the outset of a program and carried out throughout the entire life cycle. Efforts that defer VV&A to the end of a program are doomed to fail. In fact, it has been found that "hooks" must be included during model development to facilitate VV&A.

2. In order to perform VV&A, it is necessary to clearly articulate the assumptions that have been made in creating the M&S. It is rare that creators of M&S specify these assumptions clearly and completely.

3. The final step in the process, accreditation, is not application independent. It must be performed in the context of *each* specific application of the M&S.

4. For the limited circumstances under which VV&A is currently performed, it is generally too narrowly scoped. For example, in virtual simulations (or constructive simulations in which controllers are integral elements), the experience, training, and motivation of the humans-in-the-loop are essential elements of the VV&A.

5. Many current attempts at accreditation tend to be incomplete. It is rare that they specify the degree to which M&S results are applicable, credible (e.g., should the user of the M&S believe the product's trends, relative output, or absolute output?), or robust (e.g., credible in the face of changing, uncontrollable parameters).

6. The community has not yet faced up to the problem of VV&A for confederations of interoperating distributed simulations. It is necessary, but not sufficient, that simulations be valid in a standalone mode. Additional steps must be taken to establish the validity of the aggregate set.

7. It must be acknowledged that there may not always be a "solution" to the VV&A problem. This is particularly apparent for selected hypothetical future systems for which an incomplete experimental basis is available. Under those circumstances, extreme care should be taken in interpreting and employing the results from such M&S.

In view of the criticality of this subject, it is imperative that efforts be undertaken to build on MORS' experience to develop and document a practical approach to VV&A. That effort should derive rules of thumb to suggest the resources needed to perform VV&A, undertake case studies to guide im-

plementation and methodology, and seek innovative ways to implement VV&A (e.g., use visualization tools to display critical parameters, equations, and decisions).

B. M&S Use

Issue: Community Sharing of M&S In the present environment of declining resources to support system life cycle activities, the sharing of M&S across community lines (e.g., across functions and across Services) becomes increasingly significant. There is a tendency not to share M&S for a multitude of reasons, some more valid than others. Generally, each M&S application necessitates modifications to a model since modeling is application specific. If the models have been inadequately documented, VV&A'ed, and configuration controlled, the potential users of a legacy model have little or no confidence in the value of the model and tend to want start over. In addition, sharing of models implies loss of control and closer scrutiny of the models. Finally, models are often not shared because their existence may not be known outside of the community in which they were developed.

Experience suggests that the reuse of legacy models can be cost effective and facilitate the achievement of ambitious M&S and project goals. The same environments used for training have been identified as opportunities for concept development and other acquisition-related M&S activities. Conversely, acquisition M&S environments offer opportunities for training and operations. Even though the advantages of community sharing of M&S have been demonstrated, such sharing represents the exception rather than the rule. Poor discipline in model development and documentation impedes sharing. Moreover, the value of M&S sharing is dependent upon the potential user's domain knowledge (i.e., understanding of the limitations of the community model). Cross organizational sharing has been stimulated by the development and application of protocols such as the Aggregate Level Simulation Protocol (ALSP) and supporting software that permits the interoperability of disparate M&S [5].

To facilitate community sharing of M&S it is recommended that a clearinghouse of M&S be established so that potential users of M&S are more aware of community products. Policies to prescribe sound software engineering principles for M&S development and maintenance should be formulated and implemented. Cross-organizational and cross-functional interoperability of disparate M&S should be enhanced. The ALSP experience should prove useful in implementing this last recommendation.

Issue: How to Use M&S Systematically If M&S are to be cost effective, the number of simulation runs should be minimized. At the same time, however, the results must be statistically significant and unbiased. Since most simulations employ some element of stochastic modeling, it is necessary to attribute a confidence level with the observed outcome. Running more simulations helps to tighten the confidence level of the results. However, repeating human-in-the-loop simulation runs pose some special problems. With humans-in-the-loop, there is a need to avoid or compensate for the effect of learning on the M&S outcome. Learning will occur if the human is subjected to what is transparently the same scenario in repeated simulation runs.

Frequently, a significant portion of M&S resources are expended in VV&A of models and scenarios with little effort devoted to the development of a plan to exercise the resultant M&S systematically. It is not unusual for M&S sensitivity studies to vary a single parameter at a time, even though design of experiments techniques suggest that this is neither an efficient or correct approach.

The specific experimental design selected for an M&S activity is dependent upon the nature of the activity and the constraints under which it is being performed. Nevertheless, formal design of experiments techniques provide a sound foundation to guide the exercise of the M&S. For human-in-the-loop M&S, there are blocking designs that minimize learning effects. Adaptive strategies are generally preferred so that the M&S activity can be focused on the most interesting segments of the solution space. New methodologies have been introduced

recently to support efficient sensitivity analysis. One example is the technique pioneered by G. Taguchi [6]. Taguchi methods have found strong support in U.S. and Japanese manufacturing environments and their application to the M&S environment is straightforward.

The use of sound experimental designs should be strongly encouraged by suitable policies. The implementation of such policies requires guidelines for the M&S community on how to develop appropriate experimental designs and how to conduct sensitivity analyses. Finally, it is recommended that tool development to support systematic M&S usage should be encouraged. Examples of such tools include methods of configuring models for specific tests and visualization tools to illustrate the effect of changing parameters on simulation results.

Issue: The Role of Virtual Prototyping in the Acquisition Process A prototype may be viewed as a limited functionality, real-time model of the system. Typically, a *prototype* is used to explore the requirements for the user-system interface and significant effort is spent in providing an accurate rendition of that portion of the system. There is a general consensus as to the importance and utility of prototypes in helping to define the user-system interface. In addition, the utility of prototypes as an advocacy tool is generally recognized.

A *virtual prototype* is a prototype that can interface with models of other systems in an M&S infrastructure (synthetic environment). The concept of a virtual prototype is attractive because it promises to reduce the cost of system development by eliminating costly breadboard and brassboard developments. In addition it has the potential of involving the warrior as an active participant in the system acquisition process.

The virtual prototype concept can be useful only in conjunction with a synthetic environment which contains an established, accepted M&S infrastructure. Therefore, it is necessary to develop the M&S infrastructure to make virtual prototyping feasible.

A number of questions remain to be resolved concerning the interpretation of the results of virtual prototyping: How does one perform VV&A on a virtual prototype? What are the major risks associated with basing decisions on the results of studies that employ virtual prototypes? The virtual prototype's environment is also synthetic; therefore, decisions are being based on the use of limited functionality models in a synthetic environment.

It is therefore recommended that the M&S infrastructure required to use the virtual prototyping concept be developed, and specific techniques for virtual prototype VV&A be identified. Virtual prototypes should be used within the context of a formal experimental design so that the bounds on system performance and effectiveness can be estimated. Finally, the Computer Aided Design community should be stimulated to produce tools that create virtual prototypes from designers' databases.

C. M&S Tools

Issue: M&S Infrastructure An M&S infrastructure consists of the model set, databases, and networks that the community assembles as a context for performing live, constructive, or virtual simulations. *Frequently, it can cost in excess of $100M* and take years to create needed infrastructure. This poses a critical question: what strategy should be used in developing the M&S infrastructure in order to meet the needs of the C^3I acquisition community? Historically, several different strategies have been used by developers of M&S infrastructure. These have ranged from "build it and they will come" to the building of a well focused set of narrowly scoped M&S to respond to specific, well-defined issues.

Prior experiences have revealed problems with the strategies associated with both extremes. In several instances, M&S infrastructure has been built and users have *not* materialized. This failure is often a consequence of one or more contributing factors (e.g., the "not invented here" syndrome; the costs required to modify the infrastructure to meet the user's unique needs; the time required for the potential user to get "up to

speed" on the infrastructure's capabilities and uses; limited control over the infrastructure on the part of the individual user). Alternatively, the characteristics of many C^3I issues (e.g., complexity, compressed schedule) make it infeasible to create, VV&A, and exercise a M&S in the allotted time if no infrastructure is available.

In contrast to the two extreme strategies cited above, an evolutionary acquisition approach to M&S infrastructure has proven useful (e.g., FAA I-Lab). In this approach, the creator of the M&S infrastructure initially develops an M&S architecture, emphasizing the use of commercial standards and COTS products. Within the context of that architecture, an initial core capability is created rapidly to address specific, well-defined issues. Subsequently, successive infrastructure blocks are developed that reflect one or more of the following factors: lessons learned from using the initial increment(s) of the infrastructure; capabilities made feasible through M&S technology advances; a clearer understanding of the user's needs. In addition, a reliable, accessible, high-capacity backbone network is an essential element of M&S infrastructure. Even with growing network capacities, intelligent data distribution approaches are required.

D. Data

Issue: Data Needs Simulations can only be as credible as the data used to develop and exercise them. It is unproductive to develop high-resolution simulations if only approximate data is available. The key question that the M&S community faces in the area of data is the acquisition, maintenance and access to data throughout the M&S life cycle. Credible data is required during M&S creation, VV&A, and during the execution of M&S. Examples of the data needed include: force structure, combat service support (or assets and support for non-military applications); human-in-the-loop performance; tactics and operational procedures; and environmental factors (e.g., terrain, spectrum, meteorology).

Generally, it is difficult for M&S practitioners to find out about the existence of credible databases, and to gain access to them. In addition, databases required for M&S are large and should be supported by flexible database management systems.

Significant effort is required to acquire the data to test and exercise M&S. When pre-scripted scenarios are not available, their generation is both time and resource intensive. Even when data is available, it is generally necessary to transform it into a form appropriate for the specific application. A thorough understanding of the significance of each data item is necessary to insure proper use of the data in a specific M&S.

Several actions are recommended to improve the use of data in support of M&S activities. Standards should be developed to acquire and store key data items in easily accessible (within the constraints of security classification) databases. The databases should be maintained by logical experts and used on a read-only basis. Community-wide, accepted scenarios should be generated for common use, and tools should be developed to facilitate the generation of new scenarios.

V. Summary

A. Major Findings

In the area of effective creation of M&S, it was concluded that the community has not adequately addressed several critical issues. First, in assessing the technology that provides the underpinnings for M&S it was concluded that, with few exceptions, adequate technology is in place (or in progress) at the lower technology levels. However, at the technology application level, significant shortfalls are apparent, particularly in human behavior and environmental models, instrumentation, multilevel security, and automated forces. Second, under the auspices of MORS, the subject of VV&A has recently come under increased community scrutiny. It is becoming increasingly accepted (although infrequently practiced) that VV&A must be begun at the outset of a program and carried out throughout the entire life cycle (in the context of each specific application of the M&S). However, there is an unsatisfied need for paradigms that lead to cost-effective VV&A procedures. This is

particularly true for confederations of interoperating, distributed simulations. The appropriate strategy for M&S development is dependent upon the specific problem being addressed. Nevertheless, it is best to start small and have the model evolve with increasing insight. A modular architecture can support model evolution. Finally, it is concluded that model reuse as the acquisition cycle progresses and among functional areas and services is feasible only with a well-defined architectural process that includes VV&A. However, there are a dearth of the systems architectures and engineering practices that are needed to facilitate reuse.

In the area of effective use of M&S, three complementary issues have been identified. First, it has been demonstrated that reuse of previously developed models can be cost effective and facilitate the achievement of ambitious goals. However, poor discipline in the community (e.g., poor software engineering practices, inadequate documentation and configuration control) impedes effective community sharing. Consequently, the sharing of M&S across community lines represents the exception rather than the rule. Second, a formal experimental design (tailored to the nature of the M&S and constraints on its use) provides a sound foundation to guide the use of M&S. Sensitivity studies are a critical dimension of this use and can be performed effectively using emerging methods (e.g., Taguchi [6] techniques). Finally, *virtual prototyping* can be extremely valuable in evaluating system effectiveness prior to system build and in making the warrior an active participant in system acquisition; however, it can only be effective in conjunction with a synthetic environment containing VV&A'ed models, and with tools that support prototype development.

In the area of tools, the development of M&S infrastructure would significantly facilitate the acquisition of complex systems. However, because of the uncertain nature of the requirements for most of these systems (due to uncertainties in user needs and technology developments), it is desirable to acquire the M&S infrastructure in an evolutionary manner.

It is concluded that the limited availability of validated data adversely effects the creation and use of M&S. In general, it is difficult to find out about the existence of credible databases or to gain access to them. In addition, there are few instances where formal mechanisms have been established to ensure that databases are current (e.g., include latest T&E information) or validated.

B. *Major Recommendations*

In the area of M&S creation, significant enhancements can be achieved through four key initiatives.

First, there is a need to establish a research program to enhance the technology applications that are the foundation for M&S. The greatest needs for such a program lie in the areas of representing human behavior more credibly and representing a broad spectrum of environmental effects more realistically (e.g., terrain effects on the dynamics of vehicles).

Second, creators of M&S must adopt a well articulated development strategy at the outset of a program. Experience has demonstrated that it is folly to embark upon a M&S development without a clear objective and game plan. This game plan should be configured to anticipate and facilitate change. While this recommendation may appear somewhat obvious at first glance, there are subtle aspects to the clear articulation of the objectives of the M&S activity.

Consider, for example, the lack of utilization of the Strategic Defense Initiative (SDI) National Test Facility (NTF). An attempt was made to create a general-purpose set of models to satisfy a wide range of SDI-related questions. Unfortunately, the nature of the questions and the required timeliness of the answers were not fully factored into M&S development activity at the NTF. By attempting to make the models as general-purpose as possible, additional development time was required. The M&S development activity lost touch with the overall objectives of the study. As a result, the models were completed after the required answers were needed and the models were never employed in the fashion in which they were intended.

Third, the development strategy should evolve models during the acquisition cycle along two separate, coordinated paths. On the government side, emphasis should be on the development of an appropriate system environment to facilitate the formulation and refinement of requirements. Conversely on the contractor side, the focus should be on the development of tools to facilitate system implementation. Contracts should be written to ensure that the contractor M&S are fully documented deliverables.

Finally, in recognition of the criticality of the VV&A process, a practical approach to the process must be developed and implemented widely. This latter effort should build on recent MORS' experiences in SIMVAL and SEMTG.

There are several steps that should be taken to improve the use of M&S. Consistent with a recent Defense Science Board recommendation [7], efforts should be expanded to enhance the interoperability of M&S that cuts across organizational and functional lines. As a point of departure, the community should build upon the initial successes achieved through the ALSP. Second, there is a lack of understanding in the community of how to exercise M&S to derive results efficiently that are statistically meaningful. To that end, it is vital that the use of sound experimental designs be encouraged to govern the exercise of M&S. Finally, the trend towards virtual prototyping is to be applauded. However, if that trend is to be meaningful, it will require the development of an appropriate M&S infrastructure within which those virtual prototypes can be embedded. Moreover, the requirements for interfacing virtual prototypes to the M&S infrastructure must be clearly defined and disseminated to the Computer Aided Design community. Efforts to develop the capability to generate virtual prototypes from the system designers' databases should be encouraged.

In the area of M&S infrastructure, experiences in the FAA's I-Lab have demonstrated the success of employing an evolutionary approach. In this approach, the infrastructure is created by formulating broad requirements and an extensible architecture. A core capability is created, to respond to initial needs, and evolved in blocks to reflect lessons learned from its use and to take advantage of technological advances.

Finally, in the area of community data, a major initiative is required to respond to widespread needs. This includes establishing and promulgating standards for the acquisition of data and establishing and maintaining validated databases for community use. In order to assure the integrity of the latter, they should be maintained by logical experts and used on a read-only basis.

Bibliography

1. *Defense Science and Technology Strategy* (1992), Director of Defense Research and Engineering, Washington, DC.

2. Schoen, Joel M. and Stuart H. Starr, "Perspectives on the Use of Modeling & Simulation (M&S) in the Acquisition Process," (1993), The MITRE Corporation, M93B4, Bedford, MA.

3. Gados, Ronald G., "Guidelines for Certification of Strategic Defense System Simulation Model" (1988), International Test and Evaluation Association Journal Vol. IX.

4. Williams, Marion and James Sikora, "SIMVAL Minisymposium: A Report" (1991), Phalanx, Vol. 24, No. 2, p 1.

5. Weatherly, Richard M., David W. Seidel, and Jon Weissman, "Aggregate Level Simulation Protocol", Proceedings of the 1991 Summer Computer Simulation Conference, pp. 953-958, Baltimore, MD.

6. Phadke, Madhav S. (1989), *Quality Engineering Using Robust Design*, Englewood Cliffs, NJ: Prentice-Hall.

7. *Impact of Advanced Distributed Simulation on Readiness, Training and Prototyping* (1992), Office of the Under Secretary of Defense for Acquisition, Washington, DC.: Defense Science Board.

Source Selection Criteria: A Comparison of Private Sector and Government Buying Practices

By

Stanley N. Sherman
NAPM Professor of Purchasing
George Washington University

Abstract

Source selection practices in government differ from those of private sector purchasers. Reasons for the differences are attributable to government effort to introduce social policy through purchases, to maintain fairness in the award of government contracts, and unwillingness to rely on judgment of its administrators. Detailed procedures in statute and regulation and comprehensive review and audit organizations define the government methods. However, important evidence is being developed through research that the private sector practices result in more effective buying operations, more competitive markets, and a higher level of satisfaction in the buying community. Suggested modifications of government policies are based on a review of the selected research reports and case decisions.

Source Qualification and Selection, Private Sector

For approximately ten years, private sector purchasers in the United States have been revising their source qualification and selection practices with the effect of reducing the size of their supplier bases. In doing so, they are developing close working relationships with their remaining suppliers and demanding order-of-magnitude improvements in reliability, conformity with requirements, collaboration in matters of design and market, and service that is fully coordinated with the purchaser's needs. To achieve these objectives, they are adopting new practices, including Early Supplier Involvement (ESI), Electronic Data Interchange (EDI), and scheduled delivery times. Consequently, there has been a reduction in the number of competitive purchases, an increase in the length of contractual relationships and increased interdependence of buyer and seller. The motivation for these changes is reduced cost and increased competitiveness for the buying company. Experience indicates that the reduced level of competition in purchases results in increased competitive power for the purchasing company. This result is vital to companies that aspire to compete in the emerging global marketplace.

Government Policy Changes

Coincident with these developments in the private sector, the United States government has introduced a series of modifications in its purchasing policies and practices. However, governmental innovations have been aimed in the reverse direction. The Congress keynoted this period by adopting the Competition in Contracting Act (CICA) in 1984,[1] which introduced or expanded many policies and practices focused on mandating increased competition. The central policy adopted required full and

open competition for all government purchases with narrowly defined exceptions. In 1988 the Congress adopted the Procurement Integrity Act with the explicit intention of reducing interaction between government procurement officials and contractor personnel.[2] These two statutes are of particular importance in the continuing refinement of government procurement processes (other enactments have been adopted each year, but most focus on narrower issues and, overall, probably are less significant).[3] These enactments have caused the rules to be restated to emphasize the governmental preference for ad hoc, arms-length purchasing, based on objective source selection criteria, comprehensive documentation, and with primacy given to social and fairness objectives over program end results.

Recent Research in Private Sector Purchasing Practices

The purpose of this study is to highlight private sector purchasing practices by summarizing several recent study reports in which currently developing attitudes and techniques are examined through empirical and experimental research. After summarizing several such studies, a comparison with governmental practice is made through a review of federal acquisition rules and case decisions in which the federal buying practices are subjected to analysis by the General Accounting Office.

Research giving insight into private sector purchasing practices indicates that the purchasers are adopting a practice of purchasing on the basis of quality--specifically, quality that is built-in using verified in-process quality assurance procedures. Interest in these developments on the part of public buyers is indicated by their experimentation with "best value" source selection procedures, their effort to develop techniques for evaluating past performance of potential suppliers, and by public agencies' attempts to adopt a Total Quality Management philosophy.

Industrial buyers use a variety of practices that seem to deny any single-minded dedication to price competition.[4] Plank and Kijewski[5] reported in 1991 on the extensive use of approved supplier lists by a sample of purchasing managers drawn from thirty-two different SIC codes. They found that more than 70 percent of the companies surveyed establish approved suppliers lists for use of their buyers. Where such lists are used, it seems evident that selection of suppliers is a two-phase process, the first phase based primarily on an assessment of *qualitative* matters through one-on-one negotiation, plant visits, and other techniques. The second phase may or may not impose a price competition but restricts the competition to the pre-qualified buyers. These lists predominate in the purchase of production materials and of supplies and services but are used to a lesser degree for capital items. Plank and Kijewski found that use of the lists increased as the complexity of the product being procured increased. Their study was of private sector buyers. For comparison, it should be noted that severe restrictions on this buying practice are present in U. S. government procurement as is evident from the restrictive requirements for establishing qualified product lists found in the Federal Acquisition Regulation (FAR) in Subpart 9.2.[6]

Billesbach, et al,[7] in their 1986 study

of JIT-oriented companies in the United States and Great Britain found that purchasing practices in their sample of manufacturers appear to emphasize a different set of concerns from those associated with traditional (non-JIT) manufacturers. These researchers found heavy emphasis on material quality, reliable deliveries, delivery flexibility, and supplier base reduction; they found relatively less emphasis on price competition. Their study required respondents to specify the relative priority they placed on supplier capabilities and programs. When their data for their sample companies is combined, it reveals that purchasing managers place priority on supplier capabilities and practices in the following proportions:

Delivery reliability	96 percent
Conformance to quality	91 percent
Response to changing demands (flexibility)	69 percent
Use of long-term delivery schedules	68 percent
Price competitiveness	67 percent
Adoption of fixed, short-term scheduling for JIT deliveries	57 percent
Adoption of zero (incoming) inspection programs	30 percent

This data attributes a lower level of importance to price-based competitiveness than to several other factors. It does not allow firm conclusions on the relative importance of qualitative matters and price, but provides support for the notion that non-price factors may predominate in importance for JIT purchasers. Other measurements of supplier performance examined in the Billesbach study included suppliers' technical support and JIT capability. The study indicated that buyers place a moderate to high priority on these factors (50 and 42 percent respectively for the combined data base). Respondents to the Billesbach survey reported that they had substantially decreased the number of their suppliers. Some of the respondents (10 to 11 percent) had achieved greater than 50 percent reductions in their supplier base during a five-year period. However, their data did not indicate much interest in electronic data interchange, sharing of inventory information, deliveries to point of use, or deliveries within specific daily time slots.

Perry,[8] in 1992, described an analytical model by which purchasers can quantify specific qualitative factors relevant to the purchase of computer integrated manufacturing (CIM) systems (the technique might be applied to purchase of any capital equipment item). The model poses a mechanism whereby reliability, performance, durability and serviceability can be assigned quantitative values reflecting the minimum required level of performance for each. These values are then combined into a single measure--operating effectiveness. The purchaser's required level for each of the parameters (reliability, performance, durability and serviceability) may also be evaluated to assess what percentage premium the buyer would pay for a specific percentage improvement in the level of performance beyond that minimally required. In a similar manner, the operating effectiveness measurement may be evaluated to determine what premium might be paid to secure a higher level. Using this model in source selection would enable the decision maker to consider, on an

objective basis, the cost and performance capabilities of each offeror and would enable the purchaser to determine the optimum cost-benefit ratio for selection of the source. This approach requires some assumptions and may be difficult to apply. The purchaser must specify a minimum level of operating effectiveness as well as incremental levels of effectiveness. It also requires reliable seller representations regarding capabilities of proposed systems. The purchaser also must be capable of accurately assigning values to the incremental levels of capability. Perry's model represents an effective method of providing objective criteria for dealing with specific qualitative issues in source selection. For this reason, it could prove useful in the private sector and may have special appeal to government buyers. The model, however, does not resolve the policy-related, mainstream issues facing government buyers, specifically, adoption of long-term, cooperative buyer-seller relationships.

The concept of purchasing partnerships has captured attention in the private sector buying community during the last five years. In 1991 Ellram[9] developed a normative model for creating buyer-seller partnership relationships. Her five-phase model, which assumes an affirmative effort by the purchasing company to form the relationship, was derived from her case studies and literature published from 1986 through 1990. In addition to her model, she identifies factors likely to be correlated with successful partnering. These factors include total cost (not price) as an objective of the partnership, mutual trust and openness, reduction in the number of suppliers, communication occurring at many levels and functions between the firms, and sharing information with suppliers regarding changes and new product designs early in the process.

Dumond[10] reported an experimental study in 1991. She assessed the measurement of purchasing performance under four distinct management systems (each system communicated management's objectives on the basis of which the corporate reward structure was built). The design of her study required 240 subjects (grouped so that one-fourth of the total were guided by one of the four sets of management criteria) to decide a course of action from defined alternatives for each of fourteen purchasing problem situations. Of the fourteen situations, twelve involved purchasing cost savings, reductions, or avoidance as an implicit alternative. In each of these cases, the alternatives forced the cost savings objective to be traded off against other benefits, such as customer satisfaction, quality, delivery, or production cost savings. Upon making a decision, the subject received feedback on how he or she was performing against management's criteria, then proceeded to another problem to decide how it should be treated. One of the four measurement systems emphasized efficiency, i.e., purchase cost reduction, operating cost minimization, and order processing time reduction. Another emphasized effectiveness, i.e., overall contribution to profit, supplier relations, and customer satisfaction. The third system mixed the efficiency and effectiveness objectives (multiple objective system), and the fourth provided no management direction (naive system). Dumond found that when performance evaluation was based on effectiveness, the subject

achieved the highest contribution to profit, the best relationships with suppliers, and the greatest satisfaction in the end-use customer. The efficiency system resulted in the greatest cost reduction and least operating cost. In addition, she used a post-experience questionnaire to measure the 240 subjects' perception of their experience. She found that the group guided by the effectiveness system generated a higher level of commitment, a clearer understanding of objectives, a higher feeling of confidence, and greater enjoyment than any of the other groups. It is evident from these results that the effectiveness system guided the respondents to achieve the greatest overall benefit.

Dumond's findings are an important contribution to the study of purchasing practices because they show clearly that strict orientation of purchasers to price and cost minimization does not accomplish organizational objectives nearly as well as a broader orientation. This message is consistent with the growing belief that industry becomes more competitive under partnership relationships because of the focus on increased communications, delivery reliability, quality improvement, and value enhancement to the customer and the supplier.

Each of the techniques and ideas summarized from the cited reports appears to have merit as an aid to improving productivity in the United States, and some of the ideas could benefit government procurement. All of the ideas could be used in a public procurement process if the policy of governmental authority were to allow their adoption, but such policies require increased reliance on discretion and judgment by administrative personnel in the executive branch. The trend in government is in the reverse direction: decreased reliance on discretion and judgment within the bureaucracy.

Government Policies and Enforcement

One factor in the resistance of government to adoption of qualitative bases for source selection is accumulation of an increasingly detailed procurement regulatory scheme and the expansion of review and audit organizations chartered to ensure compliance with the rules. These organizations, which include the DCAA, GAO, Inspectors General and other investigative offices, are responsible for supporting the contracting process (DCAA); for ensuring proper use of public funds (GAO); and for ferreting out waste, fraud and abuse associated with public expenditures (Inspectors General). These are vital functions performed in the public interest. However, these organizations have no responsibility for accomplishing end results. A few examples of GAO decisions in award protest cases decided during the period April 1, 1991, through July 1, 1992, are examined here as illustrations of the manner in which procurement decisions are scrutinized.[11]

GAO protest decisions are the result of review by the GAO legal staff of the facts and circumstances of an agency's source selection decision in light of a careful comparison with the FAR and other regulatory or statutory rule. The FAR has been growing in the level of detail by which it defines the procedures required of the government's contracting officers. To illustrate this level of detail, selected items are quoted here. Each of the quotes has been applied by GAO in recent rulings as part of the basis for overturning a contracting officer's

source selection decision. The quotations are from FAR Part 15 which deals with negotiated procurement and is often central to protest decisions.

FAR 15.406-5(c), concerning the preparation of solicitations and the inclusion of evaluation factors for award, requires the contracting officer to "Identify all factors, including price or cost, and any significant subfactors that will be considered in awarding the contract ... and state the relative importance the Government places on those evaluation factors and subfactors." FAR 15.600, which states rules for selection of source, contains detail at FAR 15.605 regarding use of the evaluation factors. Paragraph (e) in that subsection states, "The solicitation shall clearly state the evaluation factors, including price or cost and any significant subfactors, that will be considered in making the source selection and their relative importance. Numerical weights, which may be employed in the evaluation of proposals, need not be disclosed in solicitations. The solicitation shall inform offerors of minimum requirements that apply to particular evaluation factors and significant subfactors."

At FAR 15.608 evaluation of proposals is constrained by the following: "An agency shall evaluate competitive proposals solely on the factors specified in the solicitation." Also in FAR 15.608(1) "... The contracting officer shall document the cost or price evaluation," and in FAR 15.608(2) "... the cognizant technical official, in documenting the technical evaluation, shall include--

(i) The basis for evaluation;

(ii) An analysis of the technically acceptable and unacceptable proposals, including an assessment of each offeror's ability to accomplish the technical requirements;

(iii) A summary, matrix, or quantitative ranking of each technical proposal in relation to the best rating possible; and

(iv) A summary of findings.

Finally, supporting documentation is addressed at FAR 15.612(d)(2) which requires that "The supporting documentation prepared for the selection decision shall show the relative differences among proposals and their strengths, weaknesses, and risks in terms of the evaluation factors. The supporting documentation shall include the basis and reason for the decision."

Each of these quotations is a brief extract from the comprehensive treatment of this subject in the FAR. Nevertheless, the cited items are lengthy and precise rules, and each is the product of the regulation writer's in-depth analysis of what might be characterized as a rational set of decision-making rules. Each requirement, standing alone, makes sense. In its protest operations, the GAO uses these and many other FAR rules as the basis for deciding whether a contracting agency may have failed to carry out its obligations to conform with the entire treatment of solicitation and award policy and procedure.

Agency award decisions have been overturned when GAO finds (in the judgment of its legal staff) that the agency failed to follow stated evaluation criteria. Examples of the bases for a GAO decision to sustain a protest include the following: (1) The agency reviewed an appendix that contained more pages than allowed by the solicitation (B-242289, April 18, 1991); (2) The agency record of its decision did

not support its decision that the awardee's proposal was superior to the protestor's (B-242396, April 29, 1991); (3) The agency record did not indicate proper consideration of relative technical merit and awarded to the low cost offeror, even though technical factors were stated to be more important than cost (B-243357, July 25, 1991); (4) The agency's record failed to include narratives listing the strengths, weaknesses, and risks of protestor's proposal (B-243051, June 28, 1991); (5) The agency evaluation record lacked substantive comments that supported the reduced technical scores accorded protestor's proposal (B-244528.2, November 4, 1991).

These examples are presented solely for the purpose of illustrating that the GAO regularly substitutes its judgment for that of the contracting officer or agency. Each of the decisions cited reflects careful deliberation and decision, and the rightness of the individual decisions is not questioned in this discussion. The question of interest from the perspective of this study is whether the current governmental buying system actually operates to achieve maximum public benefit. It seems important to question issues such as the emphasis on pre-determined criteria for evaluation, the demand for comprehensive documentation, the rigid constraints on communications between buyer and seller, the existence of an externally directed protest procedure, and the extraordinary detail embraced in law and regulation so as to govern the process of awarding contracts. Is this process justified? It is a process that is totally foreign to the thinking and practices that are proving to be major elements in the revitalization of American industry. The research presented earlier in this report provides compelling evidence that a more flexible buying procedure brings about greater levels of competitive activity and greater public benefit than is achievable with rigid objective purchasing procedures and policies.

Summary

Five ideas are drawn from this study as a succinct statement of those purchasing practices that are helping to make top United States companies more competitive on a global basis.

1. Timely purchasing decision-making coupled with optimization of administrative costs;
2. Verification and certification of a potential supplier's quality and reliability before allowing the supplier to compete for an award;
3. Dedication to total cost analysis after consideration of all costs associated with the purchase decision in place of simple price analysis;
4. Assessment, as part of the source selection process, of supplier willingness and ability (flexibility) to provide information and to coordinate designs and production processes with specific needs of the buyer, and;
5. Measurement of performance with recognition of superior performance though continuation and expansion (by allocation) of business.

These practices are becoming commonplace in industrial purchasing. Although not easily adopted by government because of the fear that bias or other forms of favoritism might reduce the fairness of the contract award processes, these practices are effective and reduce cost. Furthermore,

they are feasible for government. Protection of fairness and other objectives can be achieved by measures other than restrictive buying procedures.

Preliminary Policy Modification Suggestions

Comprehensive change in the volumes of regulatory material that define government buying seems unlikely. However, some guidance could be added to existing policy that would enhance the willingness of administrators to exercise sound judgment. Actions that could be adopted by the Congress follow:

1. Adopt a broadly based policy requiring pre-qualification of potential suppliers before allowing submission of proposals for other than commercial products of more than $100,000. The policy would require agencies, in advance of the release of solicitations, to publish their needs in the *Commerce Business Daily*, together with known constraints or standards that qualified suppliers must meet. Actual release of solicitations to qualified parties would be determined by the contracting officer after considering expressions of interest. To the extent needed, visitation at suppliers' facilities by a government team of experts would precede release of solicitations.
2. Adopt the following standard for entering into full and open competition: The intent of the Congress in requiring full and open competition is to obtain services and supplies for public use that constitute the best value for the public after consideration of cost, price, and quality factors. Agency contracting procedures shall be designed to carry out this objective.
3. Adopt the following standard for any decision by an agency that extraordinary measures, such as a major investment, will be initiated for the purpose of creating full and open competition: It is the intent of the Congress that agency efforts to secure full and open competition through extraordinary measures such as public investment shall be pursued only after the contracting officer has made a finding and determination that one of the following public objectives is attainable only by adopting the specific extraordinary measures:
a) after considering all expense and revenue items and finding that a net reduction in the overall cost of the undertaking will be achieved though adoption of the extraordinary measures, or
b) after determining that innovative or creative work must be acquired, and after reaching a conclusion that the requisite innovative or creative effort can be attained only by adoption of the proposed extraordinary measures.

Selected Sources

1. Public Law 98-369, Title VII of the Spending Reduction Act and Deficit Reduction Act of 1984.
2. Public Law 100-679, November 17, 1988. 102 STAT. 4065, 41 USC 423.
3. Many items of procurement legislation are incorporated into and adopted as a part of the annual Department of Defense Authorization Acts.
4. Sherman, Stanley N. "Competition and Quality In Source Selection: Private Sector/Public Sector Comparison," *Proceedings of the NAPM Annual Academic Conference, University of Southern Mississippi,* March 25-27, 1993.
5. Plank, Richard E.; and Kijewski, Valerie. " The Use of Approved Supplier Lists," *International Journal of Purchasing and Materials Management,* Spring, 1991, p. 37.
6. The Federal Acquisition Regulation (FAR) is published as Chapter 1, Title 48, Code of Federal Regulations.
7. Billesbach, Thomas J.; Harrison, Alan; and Croom-Morgan, Simon. "Supplier Performance Measures and Practices in JIT Companies in the U.S. and the U.K.," *International Journal of Purchasing and Materials Management,* Fall, 1991, p. 24.
8. Perry, James H. "Evaluating Computer-Integrated Manufacturing Systems: The Role of Quality," *Production and Inventory Management Journal*, Second Quarter, 1992, p. 18.
9. Ellram, Lisa M. "A Managerial Guideline for the Development and Implementation of Purchasing Partnerships," *International Journal of Purchasing and Materials Management,* Summer, 1991, p. 2.
10. Dumond, Ellen J. "Performance Measurement and Decision Making in a Purchasing Environment," *International Journal of Purchasing and Materials Management,* Spring, 1991, p. 21.
11. Lieberman, Richard D. "Winning Bid Protests at the General Accounting Office: A Statistical Analysis," *Federal Contracts Report,* Volume 58, p. 606. This article enumerates and classifies the entire set of 146 grounds on which GAO sustained protests during the cited time period.

SCHEDULE SLIPPAGE IN MAJOR SYSTEMS ACQUISITION

by
Dr. A. Singer
Professor of Acquisition
Industrial College of the Armed Forces
National Defense University

ABSTRACT

This paper is part of a comprehensive study involving some three dozen major DOD programs from all three Services. The paper focuses on schedule slippage in a subsample of a dozen major systems. It was found that on the average a system experienced a total of 38 months in schedule slippage before reaching Initial Operational Capability, with about half of it occurring during Engineering Manufacturing Development, and the rest of it about evenly split between Concept Demonstration/ Validation and early Production. Most programs experience significant additional schedule slippage beyond IOC because there are usually more systems in the production phase than we can adequately fund. Major drivers of schedule slippage are technical difficulties and funding "vibrations" -- mandated by Congress, OSD and/or the Services -- and associated program changes and restructuring. Schedule slippage invariably increases program cost and usually translates into significantly shorter effective field life of the system, thereby providing a considerably lower net return on the tax-payer's dollar.

INTRODUCTION

The time span from the point of launching the development of a new system to the point where it is put in the hands of an appropriate combat unit, thereby providing an initial operational capability, is usually referred to as the length of the acquisition cycle. Growth of the acquisition cycle is commonly called schedule slippage. Most major defense programs experience significant schedule slippage. This paper is based on partial

results of a comprehensive study of defense systems acquisition involving the following major programs from all three Services: Patriot, Harpoon, LAMPS, Bradley, F-15, F-16, F-18, Hellfire, HARM, IR Maverick, DSCS III, Peacekeeper, TOW 2, Tacit Rainbow, M-1, Blackhawk, Apache, Chinook, LHX, MSE, SINGARS, JTIDS, ASPJ, ADDS, T45T, FDS, NAVSTAR, GPS, DSP, DMSP, LSD-41(CV), CVN-68, CG-47, SSN-668, and DDG-51. The paper focuses on schedule slippage, in each phase of the acquisition cycle, in a subsample of a dozen major programs.

WHY SCHEDULE SLIPPAGE?

Why do we often have schedule slippage? In the most general sense, because we have great difficulty estimating the cost and performance of future new developments. Obviously, the more complex the new system and the longer the forecasting horizon, the less likely we are to envision all the difficulties we're going to encounter and therefore the higher the estimating error is likely to be. This is frequently referred to as the conspiracy of optimism. But the more flexibility the Program Manager has in exercising his best judgement regarding trade-offs among cost, schedule and performance, the smaller the ultimate schedule slippage will probably be. In this connection it is useful to compare the defense acquisition environment with that of successful companies in the commercial sector. In the commercial sector, schedule is frequently of utmost importance, because the magnitude of the profit associated with the system is frequently critically dependent on the company's ability to market it in a particular time window. Therefore, here major systems are usually developed in a highly streamlined environment where (1) the PM reports directly to top management, e.g., to the head of the company or to an executive vice president, (2) the go-ahead to proceed to the next task is usually accompanied by adequate funding to accomplish that task, and (3) the PM has considerable flexibility and authority.

A useful example is the IBM-360 which revolutionized the mainframe computer industry. Here the PM (Bob Evans) reported directly to the president of the company (Vince Learson), traded off performance for cost and schedule by using relatively conservative technology (solid logic technology or SLT vice monolithic integrated circuits), incurred enormous cost overruns, but "fielded"

the system in just over four years from conception.

By contrast, how long is the defense acquisition cycle for major weapon systems? According to the Packard Commission Report it is typically about 15 years long. And the DOD PM lives in a much more complex environment, exercising considerably less authority and flexibility. Although, as a result of recent streamlining, there are now only two management layers between the PM and the Defense Acquisition Executive, there are quite a few players in the wings, very few whom can provide the green light or the funding to accomplish a particular task, but each of whom can inject a considerable number of stumbling blocks into the PM's path.

Once the initial estimates of the system's performance parameters become known, various defense constituencies -- e.g., the vulnerability community, the reliability community, the logistics support community -- become the self-appointed "guardians" of these parameters, making it extremely difficult for the PM to trade off performance for schedule as he inevitably encounters technical difficulties. Trading off cost growth is also much more difficult than in the commercial sector because the defense PM is living in an environment where there are already many more programs in the acquisition pipeline than we can afford to fund, and where, under the best conditions, funding lead times are usually 18 months or longer. Quoting a paper by F. Biery, the Packard Commission Report proudly cites the fact that cost overruns in the defense acquisition are typically a small fraction of what they are in the commercial sector. The other side of the coin, of course, is that the defense acquisition cycle is more than twice as long.

Why should we be concerned about the schedule slippage? Because, according to the Packard Commission Report, "It leads to obsolete technology in our fielded equipment. We forfeit our technological lead by the time it takes us to get our technology from the laboratory into the field."

CONCEPT EXPLORATION

The very nature of the Concept Exploration/ Definition phase does not lend itself to schedule slippage. The purpose of this phase is to translate the functional system requirements into hardware alternatives. The primary activity is the parallel

management of about half a dozen small "study" contracts dealing with promising system-design concepts for meeting mission needs. Each of these design concepts is explored by its respective contractor in great depth, with the aim of devising a concrete plan for translating the concept into hardware and for testing and evaluating the critical features of the concept in the next phase. There is far too little visibility at this point in the cycle into the ultimate performance and cost of the system to entertain potential slippage in schedule. And, indeed, our sub-sample showed virtually no schedule slippage in this phase.

DEM/VAL

Signs of potential schedule slippage begin to appear early in Concept Demonstration/Validation and intensify as the system moves down this phase. The main objectives of the Dem/Val phase are to verify that the most promising design concepts are sound, translate them into concrete hardware, and demonstrate that the hardware can be integrated into a final system that will meet mission needs. Schedule slippage here is usually due to such factors as redefinition of the IOC, OSD or Service directed restructuring of the program, Congressionally mandated funding cuts, etc. In our subsample, the average schedule slippage in this phase was about ten months. However, this may be only part of the total picture.

Two forces are acting in this phase to partially suppress the visibility into the ultimate schedule slippage. One of these is related to the way this phase is funded; the other, to the nature of competition. In spite of the fact that the most common contract for Dem/Val is a cost-reimbursement type, most contractors usually spend significant amounts of their own money (unreimbursed by the Government) in this phase -- i.e., they frequently make business decisions to subsidize this phase as an investment towards improving their chances of winning the EMD contract and thereby ultimately the production contract, wherein defense contractors typically recoup their investment and make some profit. The immediate benefit of this subsidy to the Government is of course that the Government gets more in research and development work than it pays for. The downside is that the contractor does not always feel obligated to share with the Government all the information developed with

the company's own funds. This is compounded by the fact that the two contractors are competing on the basis of two different versions of the system. Hence, surfacing information that is indicative of potential difficulties in EMD and Production, might be construed as putting ones company "unnecessarily" at a competitive disadvantage.

EMD

With the system's entry into the Engineering Manufacturing Development phase, three key factors are introduced into the acquisition picture: funding shortages, lack of competition, and increased visibility into the system's cost and performance. All impact schedule slippage.

Prior to EMD the expenditures are relatively small (typically a total of 5% of the total system acquisition cost is spent in both of the preceding phases), and therefore the program is relatively immune to funding problems. With the systems entry into EMD, where for the first time big money is involved (25% of the system's acquisition cost is typically spent in this phase), we find that there is not enough money to fund all the programs in the acquisition pipeline and the system begins to experience funding "vibrations" and associated program restructuring.

The lack of competition stems primarily from the relatively large expenditures associated with EMD: The Program Manager usually narrows his alternatives to a single system - design concept -- and hence a single prime contractor. A number of engineering development models of the full system are built and subjected to extensive developmental and operational testing under conditions that closely resemble those the system would encounter in a combat environment. Furthermore the acquisition strategy is updated and considerable effort is expended towards laying the groundwork for the next phase, production and deployment.

The very nature of the activities in EMD provide increasing visibility into the ultimate cost, performance and schedule of the system. And the absence of competition removes most of the inhibitions to surface difficulties in these areas as soon as they arise. Indeed, most of the program's schedule

slippage occurs in EMD. In our sample the systems experienced an average schedule slippage in this phase of about 19 months -- or about double that experienced in Dem/Val. The typical reasons were budget cuts, program reductions, technical problems, and system integration and testing difficulties.

PRODUCTION

The very nature of the production phase provides full visibility into schedule slippage. The initial units reaching the field are subjected to extensive operational testing, the results of which are fed back into the production line and used to refine the methods of production, improve the subsequent lots of the system and optimize the operational concepts. Virtually all systems in our sample experienced considerable difficulty in transitioning from EMD to Production. This difficulty translated into an average schedule slippage of nine months in this phase. Furthermore, most systems experienced significant additional schedule slippage --beyond IOC and after production had been "stabilized"-- because of a lack of funding to accommodate all programs in this phase.

SUMMARY

The DOD Program Manager functions in a much more complex environment than his counterpart in the commercial sector. Thus he finds it much more difficult to trade off performance and cost for schedule. Since initial estimates of system performance parameters are inevitably optimistic, this leads to more schedule slippage and a much longer acquisition cycle. In our sample, about half the total schedule slippage occurred in Engineering Manufacturing Development phase, with the rest approximately equally divided between Concept Demonstration/Validation and early Production. Beyond IOC, systems usually incur considerable additional schedule slippage because there are more programs in the defense acquisition pipeline than we can adequately fund. Schedule slippage is one of our worst enemies -- because it robs our systems of much of their technological lead.

ACKNOWLEDGMENTS

This paper is based in part on data provided by COL E. Braithwaite, USMC; COL A. Dunn, USA, COL H. Ekstrom, USAF; Mr. W. Essig, D/N; COL A. Gustin, USAF; LTC D.K.

Raymond; LtCol J. Taylor, USAF; and Mr. M. Winston, D/N. Their contributions are gratefully acknowledged. Discussions on this subject with Messrs. G.W. Abbott and F.W. A'Hearn were very helpful. The author is also grateful to Mr. Larry L. Axtell and Mr. David K. Anderson, both of the Office of Under Secretary of Defense for Acquisition, for providing access to their files.

DISCLAIMER

Opinions, conclusions and recommendations expressed or implied in this paper are solely those of the author and do not necessarily represent the views of the National Defense University, the Department of Defense, or any other Government agency.

BRIDGING THE GAP - FROM REQUIREMENT DEFINITION TO CONTRACT AWARD

Bonnie D. Taylor, Procurement Analyst
U.S.A.F (Wright Laboratory)

Abstract - Wright Laboratory, which is the largest of the Air Force Materiel Command's four "superlabs", has been at the forefront of major changes in technology acquisition over the past three years. Their success story has been briefed to Army and Navy activities as well as industry associations and other Air Force activities with overwhelmingly positive feedback. The initiatives which resulted in dramatic improvements to acquisition leadtime were accomplished during a period of decreasing manpower with no comparable reduction in workload; and they were accomplished with existing resources and no additional cost to the taxpayer.

The improvements affected teamwork, the acquisition process itself, management and software tools which were developed in-house for consistent and efficient documenttion. The changes weren't magic and the results were not as sudden as a lightning strike, but the increase in morale and professional pride was just as dramatic. The beginning of the WL story of continuous improvement and the details of the initiatives that have made it happen are summarized here.

Introduction - Technology is not a natural evolution. Our ancestors' discovery of fire and development of simple tools for survival was significantly different than the advancements in the state of the art needed today. In order to establish a secure, national defense, to be competitive on an international level or to promote the general welfare, time is critical. The longer it takes to begin the development effort, the smaller the window for effective transition of the resulting technology. The administrative leadtime over all four stages of development from basic research through full scale development can add years to fielding or improving weapon systems. As a result, leadtime measurement has become increasingly important;and laboratories are competing for diminishing research dollars by stripping the frills from the acquisition process. Within DOD, technical excellence and a quick turnaround for an inter-agency purchase request means increased business for a laboratory.

Over the past three years, Wright Laboratory (WL) has pursued the "no frills" approach and actively managed the process to eliminate scrap and rework with remarkable success. Some of the initiatives were driven by leadtime statistics which showed a dramatic need to improve; others were the result of participation in the DOD Laboratory Demonstration Program and joint conferences. Many were developed in-house through dedicated Total Quality Management teams and independent brainstorming sessions, but borrowing and sharing with the other laboratories also played a critical role. The overall goal for all Wright Laboratory personnel was to bring the business reputation up to the same high standards as the technical reputation and to develop technology in a more timely manner.

The resulting initiatives included early development of acquisition teams and user involvement; management commitment and focus; industry participation in process improvement; measurement and

accountability; maximizing competition through increased use of Program Research and Development Announcements (PRDA) and Broad Agency Announcements (BAA); improved communications with industry and within the laboratory; an effective small business program and streamlined Small Business Innovation Research awards; as well as the use of automated tools and electronic media to improve the process. The combined effect was a leadtime reduction of 47% for competitive source selections; 45% for PRDA/BAA awards; and 81% for Phase I awards under the Small Business Innovation Research Program. The time saved in acquisition has been directly proportional to customer satisfaction and mission support. The "hows" and "whys" of each of the major initiatives are summarized on the following pages.

Teamwork - One of the biggest hurdles in the early stages was the concept of "us" vs "them". Each of the players in the acquisition process was committed to excellence while the baton was in his/her hand; but, once passed, the acquisition was someone else's responsibility. This assembly line approach failed to recognize the contribution of each member of the team throughout the process. We turned this thinking 180 degrees around by involving team members with early kick-off meetings and improved communication between the contract negotiator/contracting officer, the financial manager, and the project engineer.

The change in cultural philosophy didn't happen overnight. In 1989 a team of WL senior managers visited Phillips Laboratory to identify procedures and practices that could be implemented for improvements at home. The most significant lesson was teamwork and commitment to schedule.

Based upon the lessons learned, new milestone schedules were negotiated under the WL Commander's direction to include pre- and post- purchase activities. The new schedules and the new team strategy were briefed to all laboratory personnel through a series of acquisition seminars in the fall of 1989. The all-day seminars were designed to present a total picture of the acquisition process so team members could better understand and relate to each other's respective roles and requirements. Topics included statement of work preparation, evaluation criteria, the source selection process and other streamlining initiatives underway within WL.

Top level management attention was focused on milestone reviews with mixed results. Leadtimes improved significantly, but the emphasis on time was occasionally misunderstood at the cost of quality in documenting the acquisition process. The Air Force's implementation of the clearance process the following year added to the buyer's frustration by accomplishing reviews at earlier milestones during the acquisition. The adage that "Quality is quicker" was a major cultural change for many, but the success stories of proactive teams provided the proof of concept.

Without exception, the early involvement of all team members, review of draft documents, continuous communication during the process and the commitment of everyone to the negotiated milestones resulted in high quality documentation and record setting times. The contrast was dramatic between programs which built in quality by utilizing advisors throughout the process and program dependent upon inspection

and review at selected milestones. The leadtime from submission of the request for business clearance through resolution of issues and the recommendation for approval varied from 2 to 94 days for the extreme scenarios. The milestone reviews which focused on these variances provided feedback to management to initiate training and foster accountability. The success came full circle in 1992 when senior managers from other DOD and industry organizations visited WL to identify practices that would help them achieve the same results.

Process Improvement - Developing an awareness and understanding of the process to be improved is one of the most challenging stages of total quality management. A critical process team was formed by contracting, financial and technical managers in January 1989. The team analyzed each of the tasks required for acquisition of a program using a competitive RFP. The task breakdown structure was diagrammed on a critical path chart which covered 26 feet of acquisition activity. The chart was tangible evidence of the complexities of the process, but it also provided the visibility for targeting high payoff areas. Thirty individual corrective action teams (CATs) involving over 80 people, were ultimately formed to follow-up with initiatives in each of these areas.

Recognition of customers was important in forming each CAT and the inclusion of both engineers and contract specialists on each team was the obvious first step. As the functional members expanded their outlook on the acquisition picture to include the roles played by other team members, it became equally clear that the 26 feet emphasized Government responsibilities without providing the same level of detail for the other side of the process. In 1991 WL's annual R&D Contracting Day with Industry included representatives from the National Security Industrial Association (NSIA) in the development of material to be presented and in the seminar itself. The overwhelmingly favorable feedback led to industry representatives' joining the WL critical process team (CPT).

These external customers, volunteers from the NSIA with a relatively broad base of acquisition experience and a high level of interest and enthusiasm, were able to make important contributions to the streamlining process. Within the first two years the success stories of the critical process team resulted in over thirty policy or procedure changes for WL. One of the most visible was the reduction of internal operating instructions from 53 separate documents to 17. By taking a critical look at practices developed in-house over long periods of time, we were able to eliminate many of the adminstrative burdens we had imposed upon ourselves for problems which no longer existed.

The teams also generated process improvements affecting regulation implementation (eliminating the scrap and rework caused by regulatory changes after RFP release); Contract Data Requirements List preparation (automating the DD Form 1423 and minimizing coordinations); RFP streamlining (allowing concurrent release and review); and implementing a more timely literature search. Actions within the laboratory's control resulted in rapid implementation of change. Many initiatives requiring higher levels of approval have also been implemented and others are being actively pursued.

The selection of WL as one of the DOD Demonstration Laboratories in March 1991 provided the platform to pursue more wide-spread activity. The goal of the DOD Lab Demo program is to increase the productivity and effectiveness of the DOD laboratories through improvements in personnel management, research related contracting, facilities refurbishment and management authorities.[1] Over 60 streamlining initiatives were generated within WL in four separate areas: In-house, Personnel, Procurement and Management. The In-house initiatives dealt primarily with the acquisition of materials and equipment necessary to support the on-going activities of the laboratory; personnel issues were related to hiring authority and classification;and management initiatives involved realignment of some functional support organizations,including management reporting, and improvements in processing travel requests. Procurement initiatives affected contracting, financial and program management personnel, eliminating and streamlining documentation. Autonomy was a key thrust in many of these initiatives, providing increased delegations of authority for acquisition strategy planning, source selection decisions, and for financial management to the Laboratory Commander. By assigning program accountability and responsibility to the laboratory managers, R&D decisions are made by those with the most knowledge and expertise in Science and Technology.

One of the most dynamic changes proposed for the Lab Demo Program is undergoing review and revision. The initial draft included streamlined solicitation procedures and a simplified R&D contract format. The proposal was based in part on the current process for awards in response to Program Research and Development Announcements (PRDAs) and Broad Agency Announcements (BAAs). The approach would allow publication of the solicitation in the Commerce Business Daily, source selection based upon standard or streamlined procedures and award using an abbreviated contract document. This Tri-Service initiative demonstrates the importance of improved R&D contracting throughout DOD.

A change in philosophy for competitive range determinations was a significant outgrowth of the Lab Demo Program. Regulatory language, implemented over time, had influenced most source selection teams to retain all offerors with a technically acceptable rating of marginal or above in the competitive range. An analysis of source selection records within WL showed that over 90% of the awards resulting from competitive Requests for Proposals were made to the offeror with the highest, initial technical rating. In some cases the highest technical offeror may have also been the lowest proposed price, but the importance of technical merit in research proposals became very clear. Numerous phone calls and several trips to Washington with excellent support from headquarters personnel produced the necessary change in Air Force regulations. Competitive range determinations still give every offeror the benefit of the doubt, but only those with a reasonable chance for award are retained through discussions and the request for Best and Final Offer (BAFO).

At about the same time, legislative action resulted in increased opportunities for award without discussion. Statutory language was changed to recognize both price and other factors in the decision to award without discussions. A source

selection decision to other than the low-priced offeror no longer forces the acquisition team into discussions and BAFO. The importance of an offeror's submitting the best terms from a price and technical standpoint with the initial offer has been emphasized in the solicitations and in briefings to industry. The use of award without discussions has increased from less than 1% to more than 20% over the past two years, reducing administrative costs and time for both the Government and industry.

Increased use of PRDAs and BAAs has also been effective in reducing acquisition leadtime. The PRDA was implemented in 1982 on a test basis to encourage broader participation by science and technology based firms in meeting research and development goals as well as to decrease contracting lead times. Although the PRDA was initially developed to identify, publicize and encourage proposal submissions for basic research and exploratory development, its use as a streamlined competitive procedure has varied based upon different product center and laboratory interpretations. An Air Force Systems Command Joint Directors Conference in 1989 identified increased use of the BAA/PRDA process as a Science and Technology initiative. As a result, WL's use of the PRDA changed significantly. The percentage of competitive actions, excluding Small Business programs, awarded using PRDA or BAA procedures increased from 49% in 1990 to 70% in 1992 and the leadtime for PRDA/BAA awards was reduced from 134 days in FY89 to 74 days in FY92.

The effectiveness of WL's small business program has also had a positive impact on technology implementation. The Small Business Innovation Research (SBIR) program was mandated by Public Laws 97-219 and 99-443 to stimulate technological innovation, strengthening the role of small business in meeting DOD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DOD-supported research or research and development results.[2] Accomplishment of these goals is partially measured by how effectively the program is managed and the timeliness of processing awards. By establishing dedicated teams for SBIR negotiations, improving communications and milestone commitments from the entire team, and streamlining cost proposal analysis, the leadtime for SBIR awards was reduced from 88 days in 1989 to 17 days in 1992. This reduction reflects a highly proactive and concurrent approach between contracting and technical personnel.

In addition to improvements in the SBIR process, WL has recognized the importance of the small business contribution to technology development and transition through a well-defined and aggressive small business program. In 1992 WL was the first Federal Component of any agency to receive a Small Business Program Effectiveness Rating of Exceptional by the Small Business Administration. The surveillance report noted "efforts beyond the regulatory requirements to achieve the purposes of the small business program" and the resulting accolades attributed the success to the environment of trust, empowerment and teamwork created by WL, the Small Business Program office and the Command. Training, management emphasis and improved communication have all contributed to an open atmosphere, eliminating much of the

mystique and time consuming red-tape of Government acquisition.

Management's Role - The pressure to work "smarter and faster" followed the normal pattern of gravity, imposing the heaviest burden on the lowest tier in the organizational structure. The increased responsibility for contract negotiators had the potential for becoming a backlash of frustration and unproductive grumbling, but management was already adapting to the new needs of the organization. Good managers are made, not born; however, most supervisors have a limited amount of training in managing people. The need to balance management styles and to view employees as a customer is foreign to many supervisors whose performance is judged by the productivity of their unit. To counter pre-conceived notions and to establish a universal culture and philosophy, senior managers in the contracting organization initiated a series of offsite working sessions to identify clear goals and expected management behaviors.

Focusing on positive and productive actions, managers have made a concerted effort to promote sincerity and honesty in interactions; to be enthusiastic about the work and its importance; to treat people with respect and insure fair and equal treatment; to provide the freedom for employees to take risks and make mistakes in the interest of continuing improvement; to be interested and supportive; and to give clear and meaningful feedback. As a result, these behaviors have become the organizational way of life rather than simply "motherhood and apple pie" public relations statements.

Tools - Using resources most effectively is critical to any streamlining effort where "doing more with less" is increasingly challenging. Automation has been the solution for many of these seemingly impossible demands. This was due, in part, to internal classes on commercial spreadsheet and word-processing programs, but the most significnat contribution has been the development of unique programs in-house to automate the preparation of acquisition plans, purchase request packages, price negotiation memoranda, and contract writing tools. Tailored for R&D acquisitions, these programs have enhanced efficiency by as much as 30% to 50% and have improved overall quality.

Summary - The Council on Competitiveness issued a report in 1992 which said that most of the federal laboratories are technology-driven, concentrating on developing enabling technologies which are long-term responses to problems.[3] This was in conflict with private industry which is market-driven to look for short-term responses. Although the federal laboratories must continue to focus on the priorities of their customers, Wright Laboratory's success in reducing acquisition lead time will reduce the cultural gap between the federal and private sector. By eliminating administrative delays, the Government will put the "rubber on the ramp" that much sooner, making the technology available for both military and commercial application.

The first step toward improvement was recognition of the problem; the second was creating an environment receptive to change; but the third step was the most critical. Without management commitment and oversight, continuous improvement becomes an avalanche of good ideas without successful mplementation. Leadership is the successful bridge for ideas

that change the future.

NOTES:

1. Memorandum for Secretaries of the Military Departments Under Secretary of Defense for Acquisition (20 Nov 1989)

2. DOD Small Business Innovation Research Program Solicitation 93.1 (Washington D.C.: United States Department of Defense, Small Business Innovation Reseach Program Office)

3. Ronald E. Yates; Refitting Cold War Science (Chicago Tribune; 26 Oct 1992)

Image Management and Acquisition for the Future

by

Thomas J. Thiel, Information and Image Management Technologies

ABSTRACT

Image management technologies are maturing at an ever-accelerating pace. Enabled by newly emerging optical storage, imaging is expected to become to a multi-billion dollar industry by 1995. Does imaging relate to the reality of the acquisition office of the future?

This presentation provides an overview of electronic document image management systems including scanning from analog paper to electronic form, indexing, storage, retrieval, and the recreation of an analog image from the electronic format. The article includes a discussion of today's imaging systems, from low-end imaging systems to enterprise-wide integrated systems.

The second half of the article describes the application of electronic imaging to a contracting example from an unnamed real-world contracting office in the federal government. It discusses the existing situation in the contracting office and the problems to be addressed by an imaging implementation. Two imaging alternatives, including stand alone and networked organzation-wide systems, are presented. The impacts each of these alternatives would have on each of the problem areas is also presented. Workflow, the ability to route and to add value to a contract file's documents electronically is also described.

Finally, a strategy for implementing imaging in the contracting environment is presented. To most effectively use imaging technology, imaging systems should be integrated into an organization's overall ADP, office automation, and information management systems. Other considerations in implementing imaging includes the following: become imaging smart, let business and work considerations drive the imaging decision, involve the staff in the process, create a flexible system capable of adapting to change and new applications, and implement work process changes to take advantage of imaging.

IMAGING OVERVIEW

Imaging is one of the most important technologies of the 1990s. With imaging we can deliver superior service to our customers, improve information and knowledge processing and management, and achieve higher quality output with fewer resources. Imaging helps us to gain a strategic advantage over our competitors, to ensure our organizational survival in an increasingly competitive marketplace, and to focus on business process transformations. This author has previously discussed the use of optical disk systems for acquisition (1); in this article, a brief overview of imaging is presented. The basic components of imaging are related to the contracting activity in a following section.

Imaging is defined as the electronic management of information using digital representations of documents; these digital representations are called images. This definition generally applies to document image management systems rather than, for example, machine vision and medical picture archiving systems, which are referred to as High End Image Processing Systems.

An optical disk electronic document imaging system consists of several or all of the following integrated technologies: data management, electronic document image management, multimedia, text retrieval, and/or workflow. The goal of imaging is to enhance and preserve the value of an organization's information resources, and to optimize and streamline the organization's business and work functions.

In an imaging system, documents are stored, transmitted, and accessed on-line via a computer workstation. Most electronic document imaging systems use optical media such as write-once read-many (WORM) and rewritable optical disks, Compact Disc Read Only Memory (CD-ROM), and videodiscs for the storage of electronic documents because they have extremely high storage capacities.

A typical imaging system includes: an optical disk drive, a computer; a high resolution monitor, a raster or bit-mapped scanner, image compression and decompression boards, a laser printer, and user interface and document indexing and retrieval software (a PC-based imaging system is shown in Figure 1). A system like that shown in Figure 1 might cost about $30,000 from the GSA Schedule.

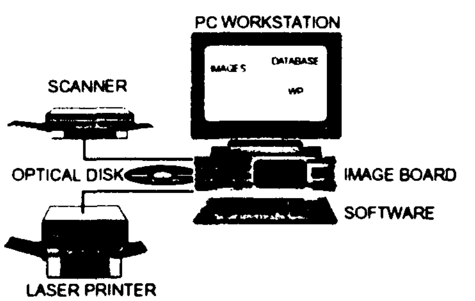


Figure 1. PC-Based Optical Disk Electronic Document Image Management System.

Document imaging is an automated electronic means of storing, retrieving, transmitting, processing, and managing documents, i.e., those pieces of paper that fill file folders and cabinets. Electronic documents can be displayed on a computer monitor or printed on paper in seconds, where and when they are needed. One of the great advantages of an imaging system is its ability to capture, retrieve and transmit all types of information, including, handwritten, machine created, diagrams, forms, photographs, and more recently, even audio, and still and motion video information.

Scanning: Bit-mapped versus Analog and Character Information

Imaging preserves the visual and spatial characteristics and appearance of the original paper document. The information universe primarily consists of analog information -- human-readable information on paper. It is relatively easy to visualize this form of information; after all we have been dealing with paper for centuries. Analog information is any information that is marked or scribed on a medium, such as paper, film, billboards, or even the walls of a cave (this page is an example of the analog form).

On the other hand, the computer stores and manages information as characters or as a raster bit-map of analog information. All analog information must be converted to one of these two forms for it to be entered into a computer. Visualizing computer information is more difficult than visualizing analog information. Additionally, the differences between character and bit-mapped forms of computer information is very significant and one of the most misunderstood aspects of document imaging systems.

With character information (word processing and databases for example), each letter or number is represented by a single combination of 8 bits (zeros or ones). ASCII code is one form of character-based computer information. For each character on the page, there is a corresponding 8 bit binary representation. That is not the case for bit-mapped information.

In order to bit-map a document, the document must be "scanned," or passed under a device called, logically enough, a scanner. The scanner "looks" at a page and divides it into a very large number of extremely small elements, called picture elements (also pixels or dots). For each pixel, the scanner determines whether the difference between that pixel's appearance and the page's background color is beyond a certain darkness level (threshold). If it is beyond this level, the scanner declares the pixel is part of the analog information on the paper and records the pixel in as a digital one. Those pixels that are indeed background or are not sufficiently dark to reach the threshold level are recorded as a digital zero. A representation of bit-mapped information is shown in Figure 2.

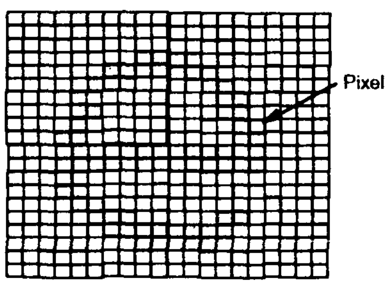


Figure 2. Scanned or Bit-Mapped Information

In order to preserve the visual and spatial characteristics and appearance of the original paper document, imaging systems store the document in bit-mapped form. Any information on a document page, including text, graphics, hand written signatures and notes, photographs, etc., can be scanned and recorded in bit-mapped form.

Storage of Bit-mapped Document Information

An imaging system typically uses optical disk storage; in fact the optical disk is one of the enabling technologies. This is because a bit-mapped page requires a very large number of ones and zeros to describe it. The computer storage needed to describe a bit-map of a page is a function of the pixel (or scanning) density and to some extent the information on the page. Scanning densities of 200 or 300 dots per inch (dpi) in both the horizontal and vertical dimension are typical. For example, describing an 8.5 by 11-inch office document at a resolution of 300 dpi requires 8,415,000 ones and zeros (300 x 8.5 x 300 x 11). Fortunately, there are computer algorithms to reduce (compress) this to a manageable level and the typical bit-map storage requirement for this page in compressed form is approximately 50,000 bytes.

Optical disk storage is generally used with imaging because it provides massive storage capabilities, is safe (only a laser light touches the spinning optical disk), and is removable. WORM and rewritable optical disks are the two primary types used (Compact Disc Read Only Memory or CD-ROM is also is beginning to be used for some applications).

WORM disks come from the supplier as blank formatted optical disks. A user can write any binary information on any specific position on the disk one time and only one time. WORM disks cannot be erased and rewritten. Rewritable optical disks are also blank optical disks that a user can write any

binary information to but these optical disks can be erased and rewritten much like magnetic disks. Both of these are written optically, that is with a laser beam. Since the laser beam is microscopic, the recording density is very high thereby providing a very large storage capability (see Table 1). Because optical disks are only touched by the light beam, they are very safe; vendors guarantee their media readability for about 25 years.

Table 1. Optical Disk Electronic Image Storage Systems

	DIA IN/CM	MFG.	STORAGE	IMAGE PAGES
WORM	5.25/13	SONY	1 3GB	26,000
	12/30	SONY	6 6GB	128,000
	14	KODAK	10 2GB	200,000
OPTICAL TAPE	12" REEL	ICI	1TB	20,000,000
REWRITABLE	3.5/9	KODAK	128MB	
	5 25/13	MAXOPTIX	1GB	

USES AVERAGE OF 50KB/PAGE COMPRESSED

Most imaging systems use WORM optical disks (rather than rewritable) largely because WORM disks cannot be altered. For example, the U.S. Nuclear Regulatory Commission (NRC) issued a guideline stating: "The optical disk technology must not allow deletion or modification of record images" (2). Since WORM disks cannot be erased and rewritten they cannot be deleted or modified.

Information Management -- Paper versus Electronic

Over time, information management in the typical office has taken on the perspective depicted in Figure 3. Office workers use the computer in the performance of their daily work routines; but for the most part, they record or document the results of their work in analog form on paper. The paper is stored in file folders contained in filing cabinets. When we need to verify, validate, resolve a dispute, or whatever, in all likelihood we must physically walk to the files, retrieve the paper file, return to our work sites, and continue with the work activity. Often retrieving these documents is a frustrating experience. Files are lost or misfiled, they may be in use by a fellow worker, and the process of finding and retrieving filed documents consumes too much time.

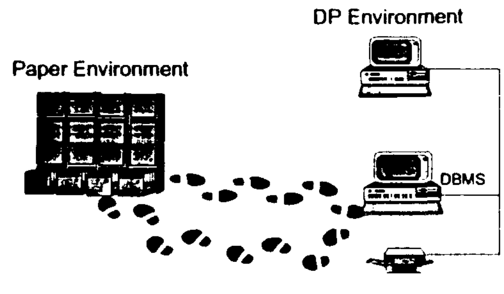


Figure 3. Traditional Paper-Based Information Management

Under imaging, the pattern of the work flow is altered dramatically (see Figure 4). Instead of storing the results of our work in analog form on paper we store and manage the information in electronic form on optical disks. These "electronic information files" may contain both image-based information in raster bit-mapped form and character information that we produce on our computer workstations in an integrated imaging system. Now when we need to verify, validate, resolve a dispute, or whatever, we no longer must physically walk to the files to retrieve the paper file. Instead, we simply retrieve and display the images of the document on our "image workstation" and continue our work activity without interruption.

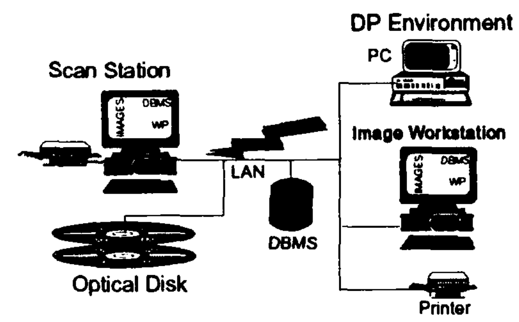


Figure 4. Optical Disk Electronic Document Image System Information Management.

Converting Paper Documents to an Imaging System

Document conversion is an expensive component of any major imaging implementation; often it is at least as costly and perhaps several times more costly than the system hardware and software costs. The steps in scanning and indexing documents include: document preparation, the actual scanning itself, indexing, quality assurance, and refiling or destroying the original documents. Many imaging systems implementors use service bureaus, companies that specialize in the conversion process.

Converting analog information on paper to electronic bit-mapped information in an imaging system and storing these "electronic document images" on optical disk for subsequent access and use is depicted in Figure 5.

Document preparation can be a critical component of document conversion. It is much more than merely removing paper clips, staples, and repairing torn and damaged pages; it should also ensure the validity of the document base. For example, it should address duplicate copies of documents in the files and other records management issues that tend to corrupt files. An imaging system does not, by itself, ensure that a mismanaged filing system suddenly becomes perfect.

Quality assurance (QA) is another important step in the document capture process. QA is nothing more than ensuring that the bit-mapped image is clear and legible and that all of the information is included in the bit map. It may be important to ensure that there is no skewing of the images or that there are no drop-out colors. This step requires an operator to visually inspect the document images and consequently is a tedious and time-consuming task. However, as operators become more and more proficient, the QA step can be performed on a random sampling basis.

The Index Database

Note that Figure 5 introduces another aspect of managing document information in image form, namely indexing (see upper right hand corner). Bit-mapped images are nothing more to the computer than millions of picture elements or ones and zeros. The computer does not recognize this bit-map like it does character information.

Therefore, all imaging systems employ an index database management system (DBMS), which contains the essence of the

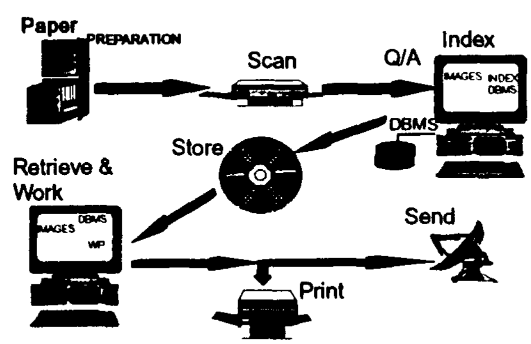


Figure 5. Steps in Converting and Using Paper Documents in an Optical Disk Document Imaging System.

information written on the original paper document page; it is used to file and retrieve image documents. The index database is the management heart of an imaging system; it provides the only road map to find information that has been scanned. This index DBMS may be as simple as a single entry; for example, a case number, social security number or contract number. On the other hand, it may be quite complex; for example, a multiple field DBMS that provides many specific elements of information about the document that has been scanned.

In fact, the index DBMS could even include the complete text of all of the scanned pages through the use of optical character recognition (OCR) technology. OCR is software which is able to take a bit-map image that represents text (such as from a scanned image of a typed page) and convert it to ASCII text characters by recognizing patterns in the image. The ASCII characters are then used to index the bit-mapped images. OCR is also used to extract information from fields or zones on the scanned pages such as data elements from a form or other standard document. The index database is then populated from the OCR output and either a full-text index or fielded database indexing scheme is employed. These OCR and indexing schemes can be very effective, but they are not inexpensive or perfect.

A bar-code can also be used to provide the crucial or key identifying information element in a document. One example of this is computer generated delivery orders which must be scanned to retain evidence of receipt of a delivered item. Placing a bar-code on the computer-generated delivery ticket provides a means to automatically capture the invoice number later on when the delivery receipt is scanned into an imaging system and to use this as the index DBMS entry.

Optical Disk Electronic Document Image Management Systems Classifications

Although imaging systems are becoming more and more solution specific, some effort has been devoted to classifying and tracking these systems. One of these classification frameworks divides optical disk imaging systems into five categories (see Table 2). Note that the general size of the configuration and its costs are also presented.

Table 2. Optical Disk Electronic Imaging Classification Framework.

SYSTEM	USERS (#)	IMAGES (#)	COST* ($)
Single User	1-2	50K	30K-50K
Work Group	3-10	1M	75K-300K
Departmental	11-50	5M	300K-750K
Business Unit	51-100	10M	750K-2M
Enterprise	100++	10M+	2M-10M+

* Excluding Conversion   Source: Dataquest

For large document storage and retrieval requirements, optical disk systems employ a jukebox. A jukebox is a device that provides storage for from five to several hundred optical disks, one or more drives, and a robotics mechanism to move a disk from the storage area into the drive (see Reference 1, Figure 5). The Sony(tm) 50-disk jukebox, for example, which occupies a floor space of a square meter or less, can provide storage for 327GB (or more than 6 million pages of paper). Jukebox storage is often referred to as "near on-line storage;" meaning that for retrieval of information that is on an optical disk platter in a storage slot, the jukebox robot has to change optical disks before the information can be accessed. This type of retrieval is usually accomplished in 20 seconds or less versus one or two seconds for information on an optical disk that is already

spinning in a drive. Large document imaging configurations with a jukebox will be presented in the imaging and contracting section.

Work Flow

Workflow management in electronic imaging systems is the ability to route and track electronic documents throughout an organization in a procedural fashion and to perform work functions and add value to a document electronically. While storage and retrieval is usually the enticement for a potential user to consider imaging, it is workflow that can really provide the most benefit from the implementation. Workflow will also be discussed in the contracting example.

IMAGING AND CONTRACTING

Introduction

The use of an optical disk electronic imaging system in the contracting environment has been presented in this forum previously (3). In the following discussion the optical disk imaging concepts described above are integrated into a real-world federal contracting function (however, the identity of the office is not disclosed).

The contracting office embodies more than 100 contract specialists who together produce and manage about 1.5 million pages of contract file documents annually. Although automation of the contract production process is presently being employed, the storage and management of the finished contract document are still being conducted with paper documents. This has lead to the twelve problem areas identified in Table 3.

Table 3. Contract Office Problem Areas

- Lost & Misfiled Documents
- Contract File Retrieval
- Records Management
- *Reproduction and* Dissemination
- Filing and Retrieving Signed Receipt Documents
- Filing and Retrieving Computer Status Repts.
- Filing and Working Space
- Interface With Automated Systems
- Customer Status Desk
- Excessive Amount Paper
- Paperless Office Goal
- Operational Effectiveness and Efficiency

Contract file document flow is depicted in Figure 6. Because of continuing file access, retrieval, and lost files problems, contract files are maintained primarily at the specialist's work site exacerbating the filing and working space problem. Those files that are maintained in the centralized contract files experience a significant frequency of lost, misfiled and out-of-file conditions.

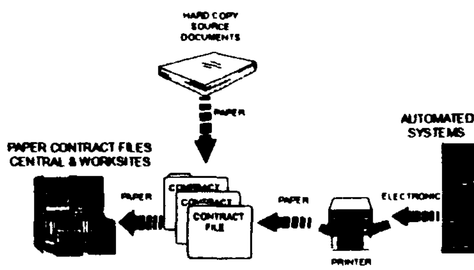


Figure 6. Existing Contract File Document Flow.

Imaging Alternatives and Impacts on the Problems

How can imaging help alleviate the situation? Two alternative configurations are proposed: 1) a self-contained or standalone

imaging system in the central files area to house the central files, and 2) an office-wide integrated optical disk imaging system. Of course, numerous configurations somewhere between these two extremities are also possible and indeed may offer the best practical solution. However, due to the space constraints of this article, they are not discussed here.

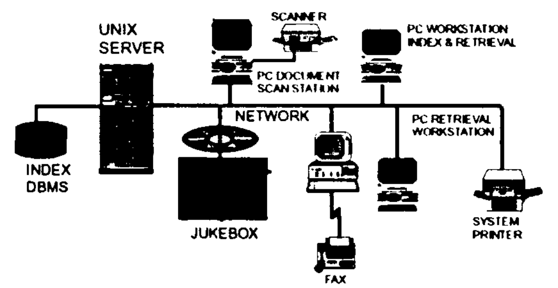


Figure 7. Configuration Alternative 1 -- Standalone Imaging System for Storing and Retrieving Contract Files.

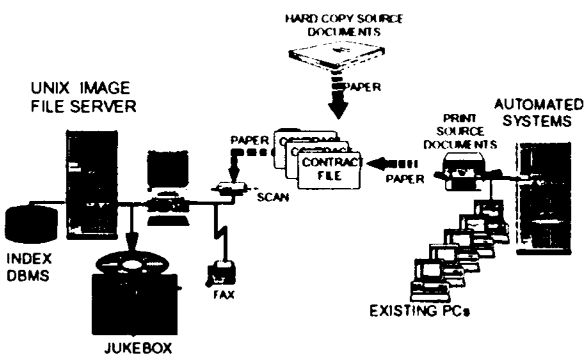


Figure 8. Contract File Document Flow With Alternative 1 -- Stand Alone Imaging System.

Standalone Imaging System for the Central Files

The standalone imaging system in the central files area to house the central files offers a partial solution to this contracting office's difficulties. This configuration (see Figure 7) consists of the following: a UNIX image and index DBMS server(s); a jukebox providing two optical disk drives and storage for at least 30 twelve-inch dual-sided WORM optical media; a scan station for converting the hard copy paper documents to electronic images; two image-enabled PC workstations for indexing, quality assurance, and file retrieval; a high-speed laser printer; and a facsimile server for FAX input and output. (Since image management systems use facsimile compression standards, a standard office facsimile can function as both a source or input station and as an output station.)

The impact of this Alternative 1 or standalone configuration on office contract file workflow is limited (see Figure 8). This configuration is very good for meeting the general contract file storage and retrieval requirements in the central filing area; however, it does very little to address some of the office's major problems (see column labeled "Alt. 1" in Table 4). For those problem areas that relate to overall organizational problems and goals, the Alternative 1 configuration also falls far short of the office's requirements.

An Office-wide Integrated Optical Disk Imaging System

Alternative 2 is an integrated office-wide optical disk document imaging system (see Figure 9). This configuration maintains the

Table 4. Impact of Alternative Configurations and Workflow on Problems.

	ALT. 1	ALT. 2	WF
Lost Documents	M	VH	VH
File Retrieval	M	VH	VH
Records Management	L	H	VH
Repro. & Dissemin.	L	H	H
Signed Receipt Docs	N	VH	VH
Computer Status Rept	N	VH	VH
Work Space	N	VH	VH
Automated Sys.	L	M	VH
Status Desk	L	H	VH
Excess Paper	L	H	VH
"Paperless Office"	VL	M	VH
Efficiency & Effect.	VL	M	VH

N = None, VL = Very Low; L = Low; M = Medium or Moderate; H = High, VH = Very High or Highest.

UNIX-based image server in the central records center but moves the index DBMS to the office's existing UNIX computer and connects the two with a Local Area Network. All of the features of the imaging system in the central records area are retained in this configuration so all of the central records functions from Alternative 1 are retained in this alternative. However, the jukebox capacity and the number of optical disk platters must be increased to accommodate the additional active contract files.

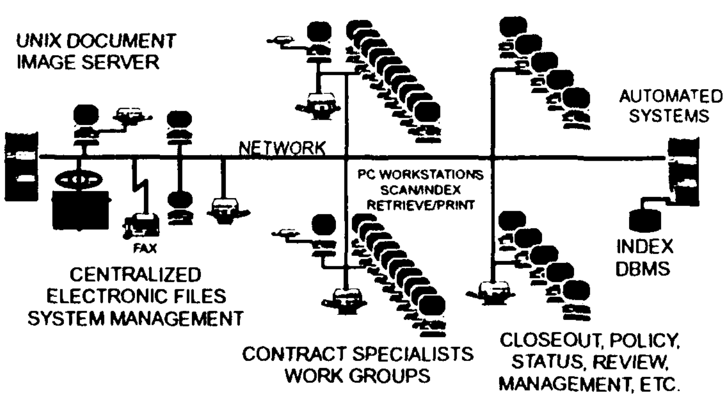


Figure 9. Configuration Alternative 2 -- Office-Wide Integrated Optical Disk Imaging System.

In the Alternative 2 configuration, all appropriate office staff (Contract Specialists, Contract Officers, supervisors, office management, oversight and policy, contract closeout, etc.) are provided an image-enabled PC. An image-enabled PC is such as the one shown in Figure 1 and includes a 19-inch high-resolution high-quality monitor and appropriate hardware and software that enable it to simultaneously access images from the document imaging system on optical disk and all automated systems and office automation capabilities of the existing UNIX-based Automated Systems computer.

The impact of Alternative 2 on contract file work flow is very striking (see Figure 10). Since it places both imaging and ADP power in the hands of the specialists and others who create contract file documents, Alternative 2 essentially eliminates all paper contract file documents. The Alternative 2 contract file is a composite of character based information from the automated systems and of scanned paper supporting documents as may be needed from the imaging system. In this configuration, the electronic contract files are captured as they are created by their creators, the specialists. Because of this, Alternative 2 has a high to very high impact on most of the office's problem areas (see column "Alt. 2" in Table 4).

Imaging and Electronic Workflow

Electronic workflow management is often implemented with optical disk imaging systems. In this context, workflow is the ability to route and track electronic documents throughout an organization in a procedural

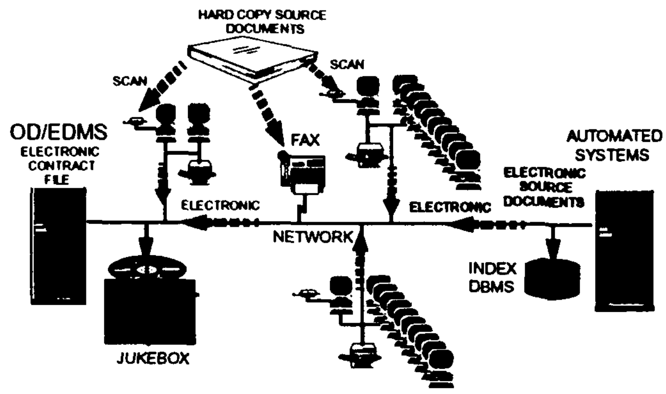


Figure 10. Contract File Source Document Flow With Office-Wide Imaging System.

fashion, and to perform work functions and add value to a document electronically. Workflow is a relatively low-cost software addition to an imaging system.

Adding workflow to the Alternative 2 configuration for contract file storage and retrieval will help our contracting office better address its problems, especially those relating to effectiveness and efficiency. A schematic representation of how electronic workflow might work in the contracting office is illustrated in Figure 11. Contract specialists (top of Figure 11) create, modify and maintain the contract file documents electronically, which are housed on the optical disk imaging system. Progressing clockwise in Figure 11, once the contract file and its separate documents have been created and placed on the optical disk, they can be reviewed and acted upon by Contract Officers and Managers electronically. The electronic workflow software manages the process of routing and approving contract documents by automatically placing documents in "electronic in-boxes." There is no "float time" associated with this process since documents are not managed in paper form.

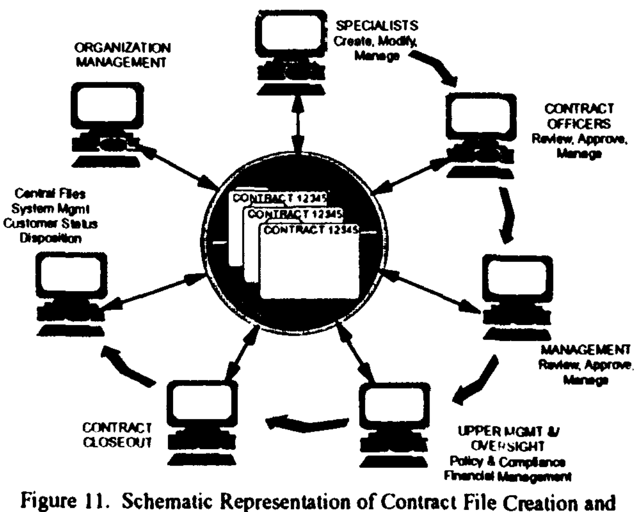


Figure 11. Schematic Representation of Contract File Creation and Management Under a Office-wide Imaging System With Workflow.

Continuing clockwise in Figure 11, Management and Oversight can electronically review the file for policy and compliance. Contract closeout can not only access the file electronically but the workflow software system can actually schedule the closeouts.

The central records center, where the imaging system and the optical disks reside in this plan, are able to use the imaging system to automate contract file disposition and removal to archives. The workflow software also provides a much greater information resource base for answering customer and vendor inquiries. Finally, workflow software provides office management with access to not only the contract files and their component

documents but also can provide statistical information on contract actions and staff work activities.

Electronic workflow can only be implemented on a configuration like Alternative 2 because to be effective all office members must have intimate and rapid access to both images and ADP functions. Adding electronic workflow to the Alternative 2 configuration has the potential to meet all of the office's needs and goals (see Table 4, "WK" column). However, in order to implement workflow serious consideration should be given to process redesign or reengineering to eliminate unnecessary paper based operational steps and to take advantage of the full potential of an optical disk electronic imaging system.

SUMMARY

Optical disk electronic imaging systems can be effectively utilized in the contract office of the future. What strategy should the contracting office follow when they are considering implementing an imaging system?

Imaging systems should be integrated into an organization's overall ADP, office automation, and information management systems to be most effective. Simple storage and retrieval imaging applications only utilize a small fraction of imaging's true potential in the contracting office.

The first thing to do is to become imaging smart. Attend imaging conferences or obtain the services of a qualified imaging consultant. The Association for Information and Image Management maintains a large library of resources that can assist you in this endeavor.

Let business and work considerations drive your imaging decision. Do not be swayed by vendors or others who are pushing a product.

Involve your staff in the process. Create an Imaging Task Force or utilize a Joint Application Design procedure. Involve specialists, records managers, managers, and information systems people in the process. Since work procedures changes are likely, an educational effort is necessary to sell the new method of doing work.

Be certain to create a flexible system, one that is capable of adapting to change and new applications. There are numerous examples of imaging systems implementations that are not being used because they were not capable of adapting to new environments and to new and additional requirements.

Finally, implement work process changes to take full advantage of the potential of imaging.

REFERENCES

1. Thiel, Thomas J. and Donna S. Ireton, "Optical Disk Systems for the Acquisition Office of the Future," Proceedings, 1991 Acquisition Research Symposium, Defense Systems Management College and the Washington, DC Chapter National Contract Management Association, Vol. I, pp. 99-109.

2. Anon., Generic Letter 88-18, On the use of Optical Disk Document Imaging Systems for the Storage and Retrieval of Record Copies of Quality Assurance Records, Nuclear Regulatory Commission, 1988.

3. Carlson, Capt. Jay S., "ICIS - The Future in Contract File Storage, Retrieval, and Research," Proceedings, 1991 Acquisition Research Symposium, Defense Systems Management College and the Washington, DC Chapter National Contract Management Association, Vol. I, pp. 69-84.

Mr. Thiel is President of I[1]-TECH, a consulting firm in Northern Virginia. He can be reached at (703) 941-4062 or at P.O. Box 11868, Alexandria, VA 22312.

A Marketplace of Ideas

by

Charles R. Thompson, CPCM

ABSTRACT

The first ten years of the Small Business Innovative Research (SBIR) program have shown the program to be quite valuable and successful. Both government and the private sector have received significant benefits to date. However, there is an untapped resource in the SBIR program: innovative proposals that have significant technical merit and commercial application potential that go unfunded by agencies each year. Agencies' inability to pursue them may result from insufficient SBIR funding, or because they are not sufficiently relevant to the agencies' missions.

Our hypothesis presented herein is that some number of those meritorious but unfunded proposals could be of interest and value to prime contractors, academic institutions and other possible investment capital sources, and might be picked up for support if their existence and merits could be made known widely. The paper suggests a concept referred to as "A Marketplace of Ideas" to help facilitate pursuit of some of these innovative concepts by interested parties outside the government, in the belief that such activities would be in the national interests. The Marketplace of Ideas would provide all SBIR agencies the opportunity to publicize all suitable unfunded Phase I and Phase II proposals through an on-line database of proposal abstracts open to the public with relatively little expense. *

INTRODUCTION

Public Law 97-219 enacted 1982, created the Small Business Innovative Research (SBIR) program. Beginning in Fiscal Year 1983, it required all Federal agencies with annual extramural R&D budgets in excess of $100 million to set aside a portion of their budgets to fund small, high-tech businesses for the development of innovations they have proposed. In recent years, the fraction has been 1.25 percent.

The enabling legislation stipulated four purposes of SBIR:

To stimulate technological innovation;

To use small business to meet Federal R&D needs;

To increase private sector commercialization of innovations derived from Federal R&D; and,

To foster and encourage minority and disadvantaged participation in technological innovation (SBIR is not a minority or socioeconomic disadvantaged set-aside, however).

Eleven agencies conduct SBIR programs and have applied approximately $ 2.75 billion to the program from inception through Fiscal Year 1991.

The program has been judged quite successful both by the government and the private sector. Agencies with SBIR programs have availed themselves of some of the most original thinking in the nation on a wide variety of topics that relate to their mission interests and objectives, and many offerors compete vigorously for grants or contracts. The program has been re-authorized twice by subsequent legislation, in 1986, and in 1992, with each re-authorization broadening and extending the program. The current sunset date for the program is October 1, 2000, but further extension will be considered by the Congress before that date.

A measure of the perceived program value and success is that the October 1992 legislation, Public Law 102-564, increased agency SBIR set-asides to 1.5% of their extramural budgets starting in 1993, to 2.0% in 1995. and to 2.5% in 1997. The 1992 legislation also increases emphasis on the goal of commercial applications in the private sector, and charges participating agencies with finding means to encourage and facilitate this objective.

SBIR is conducted in three phases. Phase I explores the feasibility of selected innovations through 6-month grants or

* The assistance of Harry W. Johnson, Director, SBIR Program, NASA, is acknowledged and appreciated. This article reflects only the author's views and does not represent the position of NASA or any other agency.

contracts, normally not exceeding $50,000. Phase II, which is restricted to Phase I participants, is the principal SBIR activity. It continues the development for up to two years of (typically) one-third to one-half of the Phase I projects, using contracts normally not exceeding $500,000. Both Phase I and Phase II projects within each agency are chosen competitively on the basis of evaluations of proposals received in response to program solicitations issued by the agency, suitability for agency programs and missions, and available funding.

Phase III is the development of commercial applications by the small business contractors, but it can also be the extension of project development and/or end-use procurement by the government of projects carried through Phase II. Phase III is not supported by the SBIR funding set-aside, but must use private sector funds in the case of commercial applications, and non-SBIR federal funds in the case of continued agency development support.

The large majority of innovations proposed by small businesses for SBIR support are never funded by the agencies. While a large fraction may be judged unsuitable for award selection, many proposals which have considerable merit are not selected due to funding limitations despite their technical interest and merit. Any of those worthy ideas that are not explored are costly. Those not selected entail a loss of resources expended by the proposing firms in developing their proposals, but even more significantly, they may represent potentially much larger losses to the nation due to the lost opportunities for ultimate applications of the innovations.

This paper presents a concept called "A Marketplace of Ideas" for the SBIR program in which agencies would assist small businesses seeking support for their innovative ideas that the government cannot fund through the SBIR or other agency programs. the concept could help prevent the loss of valuable development opportunities by assisting prime contractors and other possible private sector funding sources (and possibly nonprofit sources as well) to learn about those small businesses and their innovative ideas. The potential benefits to the Nation and its competitive strength could be very great.

DISCUSSION

Since the beginning of the SBIR program in 1983, it is estimated that more than 5,000 small businesses have submitted at least 140,000 Phase I proposals through Fiscal Year 1991, to the government proposing innovations in response to the annual Program Solicitations published by each participating agency. There have been about 16,000 Phase I awards and 5,100 Phase II awards through the end of Fiscal 1991 government-wide, which means approximately one in eight Phase I proposals received are funded, and only about one-third to one-half of the funded Phase I projects are subsequently selected for Phase II continuation. The table below illustrates recent statistics from the 1990 SBIR program of the Department of Defense, whose SBIR set-aside annually accounts for more than half of the total SBIR funding of all agencies combined.

Service	Proposals Recd.	Phase I Awards	% Awarded
Army	998	92	9.2
Navy	2139	323	15.1
AF	3479	337	9.7
DARPA	596	100	16.8
DNA	213	14	6.5
SDIO	860	155	18.0
Total	8385	1021	12.2%

The table shows that DOD awarded Phase I contracts for 12.2% of the proposals received. Considering the program guidance, fund availability, award selection criteria and other factors, perhaps the 12.2% award rate is the best obtainable result.

However, the table also indicates that 87.8% of the proposals were not awarded. Of those 7,360 proposals not awarded, we speculate that some are not worthy of award on technical grounds. In addition, NASA SBIR program officials similarly indicate that many of the Phase I proposals it reviews are not viable and should not be funded for technical reasons. However, we believe that there may be merit in some of the proposals not awarded, and that they were not awarded

simply because of funding or other program limitation. We believe that some of the unfunded proposals are a resource that is going untapped.

Several agencies (NASA, for example) estimate that half to two-thirds of the Phase I proposals they receive are not suitable for award by them, for a variety of reasons. Unsuitable proposals may be based on erroneous physical principles, or may be viewed as infeasible or impractical. Some may simply be off-target in not meeting agency needs. Still others may contain good ideas that have already been investigated. However, several agencies estimate that the number of proposals they find suitable for award selection is roughly twice the number they are able to fund. Our hypothesis is that some of the meritorious innovations agencies cannot fund may represent potentially significant losses to the country if not pursued outside the SBIR program.

The situation in Phase II is similar, but probably of even greater significance. Phase II proposals concern innovations whose basic feasibility has already been explored during Phase I. Not all Phase I projects may be found to have enough value to warrant continued funding by the government, but as in Phase I selections, the number of Phase II projects funded each year is usually limited by available funds, not by a shortage of good proposals from which to choose. Agencies typically are able to select perhaps only half to two-thirds the number found to be award-worthy. However, all those award-worthy proposals represent ideas whose feasibility has been demonstrated in Phase I and represent significant investments on the part of both the government and the small businesses that did the research. The likelihood of loss to the nation by not continuing development of these ideas could be greater than for many of the apparently meritorious Phase I concepts that were not selected for award and whose feasibility was never established.

It is suggested that each agency should make available - with the approval of the proposing firm - the abstract of technically acceptable but un-awarded Phase I and Phase II proposals to industry and academia. The primary objectives are clear:

* To assist small businesses in their marketing activities without increasing their administrative and marketing costs, by exposing their innovations to a broad range of potential sources of development funds and other business arrangements for pursuing development. In many instances, small firms might not know of or be able to afford such opportunities on their own.

* To make available to industry and academia an organized display of innovations and available talent from which they can decide whether further inquiries may be in their interests. This should open up otherwise unknown opportunities for increasing their own corporate objectives through new, innovative ideas.

Agencies having SBIR programs would be encouraged to provide the necessary data from their annual proposal information databases, indicating which proposals have been selected for award, and also if feasible to do so, noting those proposals judged to have sufficient merit within their agency to have been selected for award by the agency had additional funds been available. Proposers would also need to give assent to the exposure of the abstract and title data of their proposal. Those who decline would not have their proposals included in the database.

Other potential users of the database could be the many state-supported organizations encouraging small business entrepreneurs and supporting local and regional research and development. Many states have programs complementary to the federal SBIR programs involving some form of economic assistance and other business development support, including some form of matching funds for firms winning SBIR awards. Some states provide direct funding, grants, loans, loan guarantees, tax advantages or other information to small businesses. A 1987 study by the National Governor's Association reported that there were 31 states with offices that promote the growth of technology-based businesses. However, few of such organizations are able to stay abreast of all potential sources of innovations that could be of interest to them. The proposed

database, "Marketplace of Ideas", may be of direct interest to the states with economic assistance programs.

The Marketplace of Ideas initiative would provide another beneficial opportunity for Federal agencies themselves. Both the Administration and the Congress are vitally concerned with technology transfer from Federal R&D programs to the private sector to benefit the overall economy and national well-being. But, heretofore, it has been a not-uncommon perception - whether true or not - that Federal agency efforts in that direction may be less than enthusiastic or effective. The Marketplace of Ideas would be one positive and visible indication that would help agencies dispel possible images of reluctance or inability to advance tech-transfer objectives.

IMPLEMENTATION

The Marketplace of Ideas concept could be implemented with little expense or additional effort for an agency. A preliminary implementation plan should consider these features:

Step 1 - Survey

A selected lead agency conducts a survey to determine potential acceptability of this idea by gathering comments on the concept of an SBIR 'Marketplace of Ideas' from:

* Small firms that have proposed on, but not won, contracts in the SBIR program (Phase I or II) in the past two years

* Potential large business/university users of such a database of proposals

* Trade associations and other interested parties (NSIA, NCMA, etc.)

Conducting this survey and summarizing the results in a report and briefing for the lead agency, the Small Business Administration and the Congress, are suitable tasks for a contract to a small firm. The effort could possibly be accomplished in 60-90 days after contract.

Step 2 - Database Establishment

Assuming an affirmative result in the survey, the lead agency awards a contract to a data processing firm to

* Create a database of all SBIR Phase I proposal abstracts that were technically acceptable but not funded, and those Phase I projects that were not selected for further funding in Phase II

* Obtain authorization from the small business to list his or her abstract in the database

* Vigorously market on-line access to the database by the public, thereby generating revenue to pay for, or at least offset, the cost of the effort

* Report revenue and expense to the contracting officer

* Operate the on-line database for at least a year to prove the concept

* Provide for periodic assessment of the usefulness of the database, evaluating user suggestions for improvement.

Step 3 - Database Operation and Extension

Assuming success of the survey and demonstration steps, the lead agency modifies its SBIR policy to permit an operational extension of the database, with the intention of fully developing the concept based on test experience.

The agency also executes a public information program to support the concept of a "Marketplace of Ideas" and to publicize its success, to include Congressional notification of a successful initiative.

Other SBIR agencies then adapt the lead agencies implementation to their own programs.

The SBIR "Marketplace of Ideas" should be endorsed by every agency Director of Small and Disadvantaged Business and by the Small Business Administration.

The Marketplace of Ideas could well be an initiative adopted by the SEA and operated on a government-wide basis for the eleven agencies that now participate in the SBIR program.

CONCLUSION

The Marketplace of Ideas identifies abstracts of technically acceptable SBIR Phase I and II proposals that were not selected for funding, and displays them in a computer searchable, on-line database available to the public. The database will be advertised publicly and especially to other government agencies, prime contractors, universities, and state government economic development agencies. The principal benefit of making available these unawarded SBIR proposals is to give them a greater chance of obtaining funding from another source without the administrative expense of making another proposal. The Marketplace of Ideas can be established in a cost-effective manner with a revenue-generating feature so as to make it a no-cost or very low cost investment by the agency. This idea is easily adaptable to all federal agencies with SBIR programs.

***

Author Note

Charles R. Thompson is a former contracting officer with the US Army. He is a senior staff consultant with Consulting On Government Procurement, Inc. He is a Fellow, a CPCM and a member of the NOVA Chapter, NCMA.

ELECTRONIC DATA INTERCHANGE (EDI)—THE GATEWAY TO BUSINESS IN THE 21ST CENTURY

by
August J. Trottman
Head, SPEDI Operations Division
Naval Air Warfare Center Weapons Division
China Lake, Calif.

ABSTRACT

Electronic data interchange (EDI), used in conjunction with current bar code technology, offers almost unlimited possibilities for improving business efficiency in private and public sectors of industry. This article documents how EDI technology has been utilized by the Naval Air Warfare Center Weapons Division (NAWCWPNS), China Lake, Calif., to improve its procurement, financial, and supply operations.

In January 1989, Center management chartered a study team to investigate the small-purchase acquisition process. The team's findings confirmed that the process was bogged down with paper trails and manual approvals and was not meeting customer needs.

Small Procurement Electronic Data Interchange (SPEDI) was born after researching government and private sector purchasing operations. Using an EDI systems contracting approach, the process allows customers to place electronic orders against established contracts utilizing on-line catalogs. All approvals, including funds availability, are also accomplished electronically. Orders, which take the form of bar-coded labels, are printed at the contractor's facility and are affixed to the packaged delivery items. The contractor then has 24 hours to deliver. The receiving process is accomplished by scanning the bar code on the package labels, an action which also creates the contractor's invoice. The use of SPEDI has reduced payment to less than 10 days.

The NAWCWPNS study team anticipated that by entering into longer duration contracts with reduced payment terms, quantity discounts of 10% could be obtained. Presently, two contracts are on line with discounts exceeding 40%. Performance has been excellent and is tracked by the SPEDI software, as is historical data such as usage and pricing.

INTRODUCTION

On 3 January 1989, Naval Weapons Center (NWC—which was officially designated NAWCWPNS on 1 January 1992) management chartered a team to investigate the Center's small-purchase system (actions of $25,000 or less); identify, describe, and prioritize actual NWC needs; and develop a process that would minimize the time and effort necessary to acquire materials and supplies. A systems viewpoint was advocated that would emphasize technical and program needs and would consider the requirements of each functional area affected by the new process. The team was composed of four disciplines: automation, comptroller, supply, and procurement, with a software engineer as the team leader. The final report, due in April 1989, was to include an analysis of the existing small-purchase system, a recommended new approach, anticipated savings, level of in-house effort, and costs required to implement the new process.

To accomplish its task, the team initiated a two-pronged approach. Each of the line support activities—procurement, supply, and comptroller—reviewed their processes associated with satisfying small-purchase requirements. At the same time, the team began extensive data-gathering to learn how other activities in both the government and the private sector were accomplishing their purchasing needs. In conjunction with this phase of the research, a formal Request for Information (RFI) was issued to industry to determine what technical expertise was available to assist activities in a process improvement endeavor of this type.

FINDINGS

The small-purchase process analysis demonstrated that during FY 88, routine, nonurgent requirements had an average lead time of 95 days from conception to NWC delivery, and an average cost of $154.08 for each stub (purchase request) submitted. The small-purchase flow process at that time is shown in Figure 1.

The typical purchase request required the customer to manually research the item of interest, initiate a purchase request form, obtain management and budget approvals, conduct special reviews to determine if the item was subject to any federal, state, or local regulations (environmental, health, etc.) and then submit the request to the procurement office. At that time the comptroller was notified to commit funds in anticipation of the item's procurement. This process typically took the customer 20 days to accomplish.

Prior to entering the procurement office, the request had to be screened by the Technical Branch of the Supply Department to determine if it could be purchased locally from the open market or if some mandatory source, such as the Federal Prisons or General Services Administration (GSA), was directed.

After approval for open-market procurement, the requirement was competed to obtain the best price for the government, a purchase order was issued to the contractor, and the comptroller was notified of the funds obligation. On the average, the screening and procurement processes added an additional 30 days.

Routine deliveries were averaging 45 days after the vendor received the order. Receipt at NWC consisted of inspection and acceptance of the item by the Supply Department with eventual delivery of the item to the customer. A receiving report was submitted to the comptroller for final costing of the obligation. Payment to the contractor then followed within another 60 to 90 days.

The team's findings confirmed that the small-procurement purchasing process

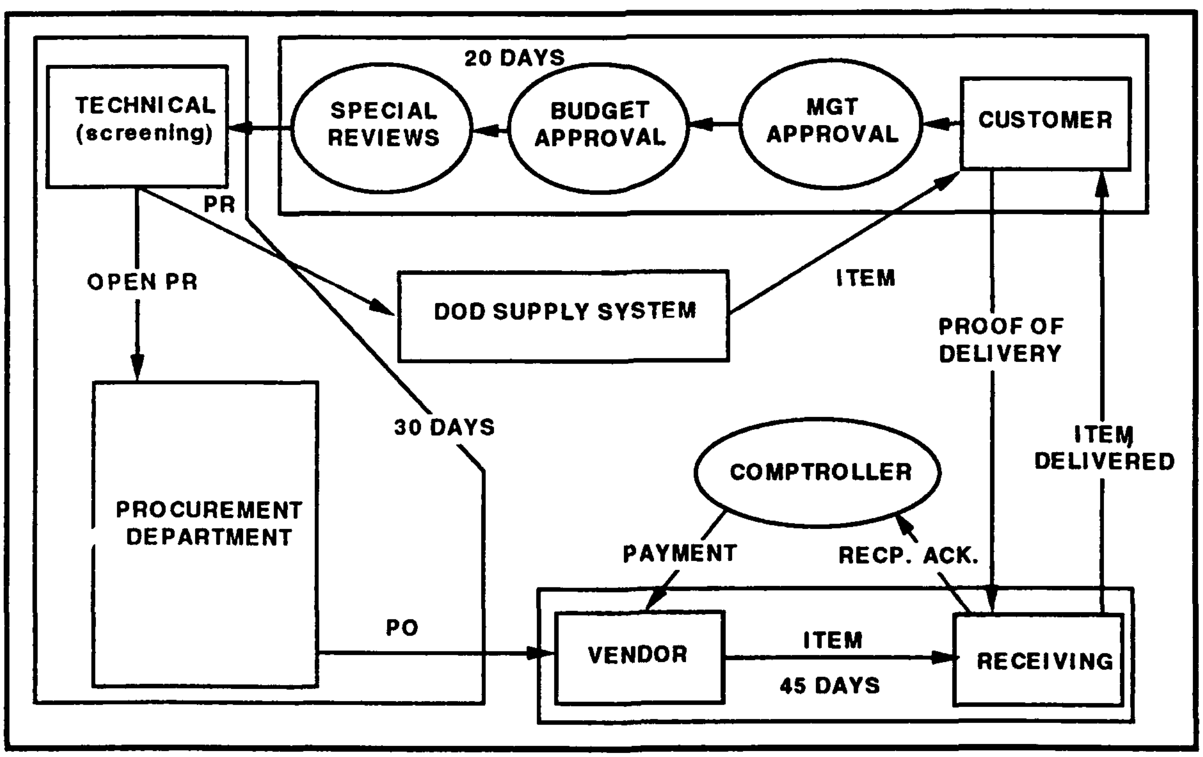


FIGURE 1. Small Procurement Flow Process (FY 88).

was bogged down with paper trails and manual approvals; a self-serving system that was not meeting the customers' needs.

The RFI produced over 20 respondents who possessed a significant degree of expertise in the area of procurement process improvement. The team also visited several contractor facilities and other government activities to see how they were performing their procurement functions. It became immediately apparent that almost every successful process viewed involved some type of automation used in conjunction with EDI and bar code technology. Of particular interest were the systems at Sandia National Laboratories and Los Alamos National Laboratories in New Mexico. They had in place a series of requirement-type contracts for commodities ordered, received, and paid for using EDI and bar code technologies. The SPEDI concept was patterned after portions of these examples.

After analyzing the accumulated data and comparing the results to the Center's needs, the team recommended a systems contracting approach that would take full advantage of state-of-the-art EDI and bar code technologies. The approach was approved by Center management in September 1989. Since the small procurement arena was the area being explored, SPEDI was born.

DISCUSSION

The SPEDI process is implemented through three mechanisms:

1. Delegation of controlled, limited small-procurement authority to the customers

2. The award of long-term *systems contracts* for commodity classes of supplies and materials

3. The utilization of computer technology to provide communication, control, and accountability

The first two mechanisms of this process could be implemented only through automation and by themselves could not provide the integrated benefits of a total systems approach. However, the third mechanism was much more complicated.

Communication includes replacing the paper procurement request with an electronic equivalent that provides catalog searches, procurement path determination, order placement, receiving, payment initiation, and trouble processing through automation.

Control consists of automated procurement authority determination; funds validation; hazardous, critical, or sensitive material monitoring; and delivery stage tracking.

Accountability includes automated tracking of purchases by delivery stage, shop code, type of funds, type of item, buyer history, and vendor delivery. This process flow is shown in Figure 2.

Development of the SPEDI information system featured a relational database configured in a client-server architecture. Access to the client is achieved from each customer's desk through a networking or modem communication. Customers with authority to order through the system are called SPEDI Ordering Officers (SOOs). SOOs use SPEDI to search electronic catalogs and place automated delivery orders (DOs) from their remote workstations through the client server directly to systems contract vendors using EDI.

The SOO receives a warrant from the Head of the Procurement Office after viewing a 48-minute video and receiving hands-on training in the database's use. Because of the extensive checks built into both the systems contracts and automation, the SOO's authority is quite limited and is rigidly controlled. This extensive control and accountability allows large numbers of SOOs to be established, which reveals the heart of the process—allowing the customer to deal directly with the contractor.

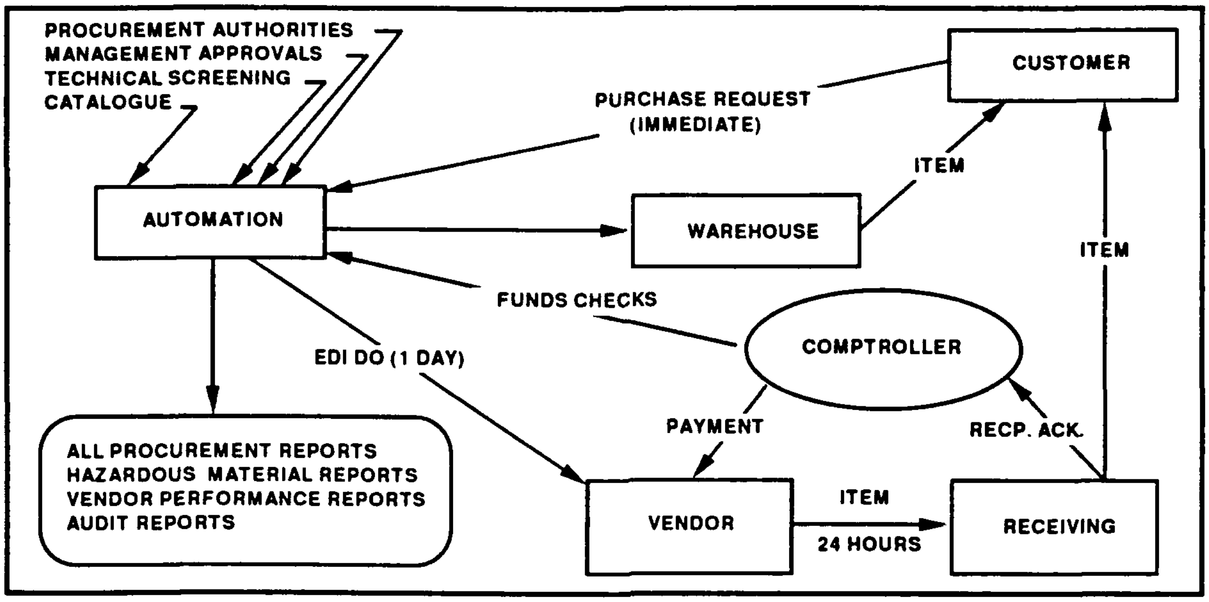
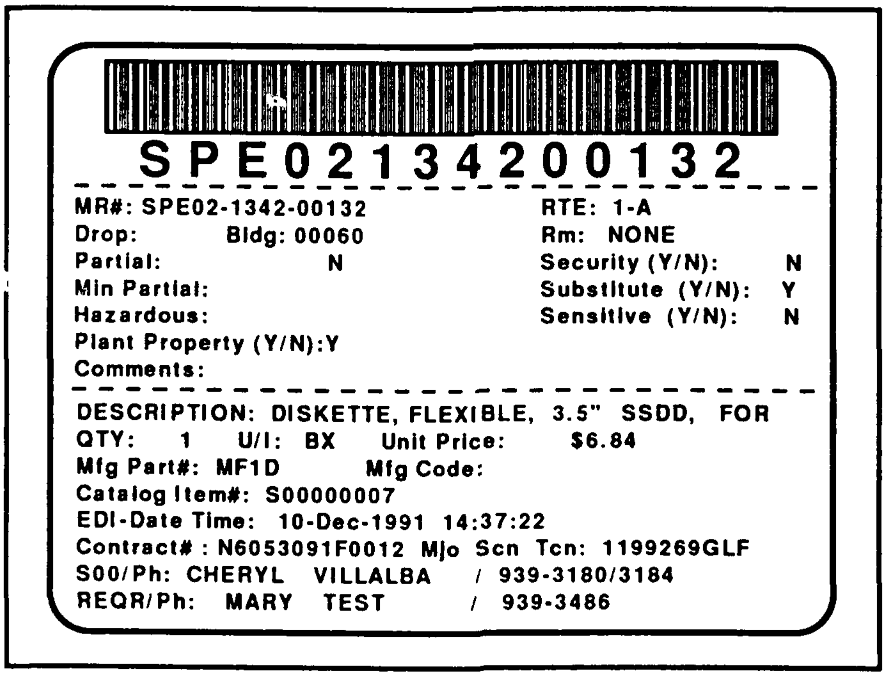


FIGURE 2. SPEDI Process Flow.

The SOO's authority to procure specific items (i.e., precious metals, chemicals, etc.) is checked electronically at the time the order is placed. An interface with the accounting system ensures that the funding citation is valid, contains sufficient funds, and is proper for the type of purchase being made. Delivery orders, which take the form of bar-coded labels, are printed at the vendor's site and are attached to the delivery package. No procurement documentation other than the 3- by 4-inch bar code label is produced. A sample delivery order is shown in Figure 3.


SPE02134200132

MR#: SPE02-1342-00132 RTE: 1-A
Drop: Bldg: 00060 Rm: NONE
Partial: N Security (Y/N): N
Min Partial: Substitute (Y/N): Y
Hazardous: Sensitive (Y/N): N
Plant Property (Y/N):Y
Comments:

DESCRIPTION: DISKETTE, FLEXIBLE, 3.5" SSDD, FOR
QTY: 1 U/I: BX Unit Price: $6.84
Mfg Part#: MF1D Mfg Code:
Catalog Item#: S00000007
EDI-Date Time: 10-Dec-1991 14:37:22
Contract# : N6053091F0012 Mjo Scn Tcn: 1199269GLF
S00/Ph: CHERYL VILLALBA / 939-3180/3184
REQR/Ph: MARY TEST / 939-3486

FIGURE 3. SPEDI Delivery Order.
(Actual Size.)

The vendor has a limited time frame in which to deliver; typically, at NAWCWPNS, it is 24 hours. Upon receipt of an order, government receiving personnel scan the bar code label. This process electronically creates receiving and costing documentation and initiates payment to the vendor. The system is designed so no partial deliveries are accepted. If the entire quantity cannot be furnished, the shortage is canceled and must be reordered. Bar code scanning is also used to indicate when the item is moved from the dock onto a delivery truck and is finally delivered to the customer. This step of the process creates a *paperless proof of delivery* and is accomplished by scanning the item's bar code label and the employees' (delivery person and customer) badges with hand-held bar code scanners. The scanned items are subsequently downloaded into the SPEDI database. All transactions are automatically time-stamped for reviews, reports, or audits as necessary.

SPEDI has reduced procurement item lead time from 95 days to typically under 3 days and has reduced payment to vendors from 60-90 days to 10 days or less.

DETAILED NARRATIVE DESCRIPTION OF THE SYSTEM

A context diagram showing the complete SPEDI system is presented in Figure 4. The automation is accessed by the SOO who logs into the database and provides a unique user identification (password). The password is used to determine authorities that the SOO has and the funds that he or she may use. Upon access to SPEDI, the SOO has three basic options: place or change an order, perform inquiries (status of an existing order or to obtain data on a series of past orders), and search the electronic catalogs. These options are indicated in Figure 4.

The government provides each vendor with an identification number that is necessary to access the automation through a security handler to obtain daily orders. Strict security is maintained to ensure that each vendor can only access his or her personal order queue. No access is permitted to other vendor files, any other part of the SPEDI database, or other government automation.

As previously mentioned, financial information flows in and out of SPEDI. The input is an ongoing updating of fund citations to be used by the SOOs and as costing/payment

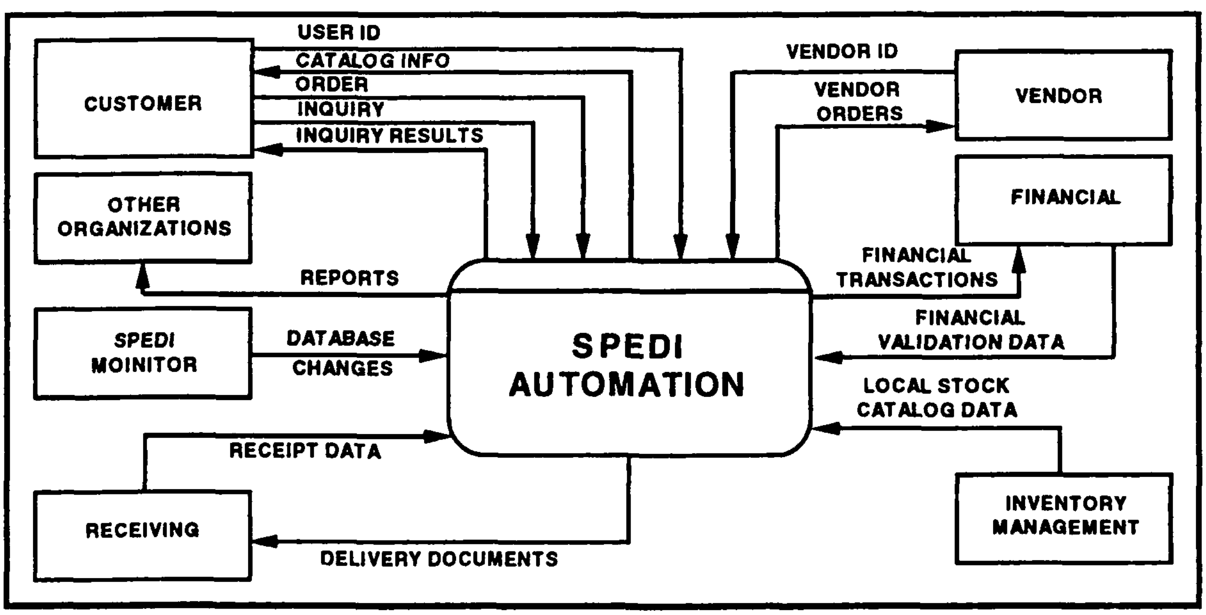


FIGURE 4. SPEDI Context Diagram.

data. The scanning of delivered orders creates the vendors' invoices, which are transmitted once a week by electronic tape to the comptroller for payment. This is one of the major benefits provided by the process since the vendors' invoices also serve as the receiving reports; therefore, payment can be made immediately.

In addition to the items provided by commercial contractors, the SPEDI database also contains all of the items carried as inventory by the Center Supply Department, which is treated as another SPEDI vendor. If an item from local stock is requested, the order will automatically be passed to the Supply Department. Inventory Management submits bimonthly catalog updates on locally stocked items to the SPEDI database.

Receiving's automation interfaces have been discussed. The SPEDI database administrator (monitor) has unlimited access to the automation and is responsible for database changes, training SOOs, and customer service. Other organizations can be authorized limited access to SPEDI for online data retrieval and special reports.

Figure 5 shows the five primary modules that make up the SPEDI database. For the most part, each module deals with one or more of the functions described in Figure 4.

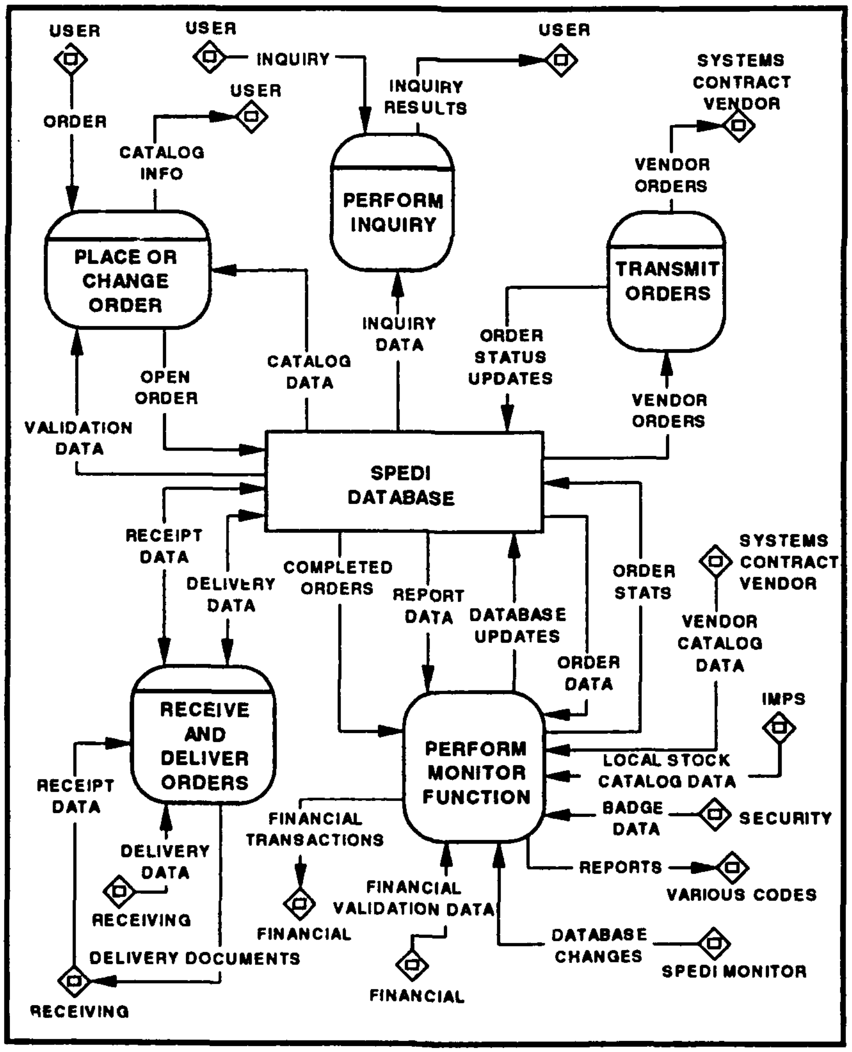


FIGURE 5. SPEDI Automation Module Diagram.

ADDITIONAL BENEFITS

Electronic catalogs are a unique aspect of SPEDI. Each vendor's items are loaded into the database by Federal Supply Classification, manufacturer's part number, local part number, and key word(s) identifier which facilitate on-line searches. Additional descriptive information may also be viewed once the item is located. During the solicitation stage, floppy disks are provided to offerors to be used in submitting their proposals. Not only does this expedite the evaluation process, but it allows direct uploading of the successful offeror's items into the SPEDI database.

Software reporting capabilities include, but are not limited to:

Status of delivery orders	On-line
Utilization by fund citation	On-line
Utilization by customer	On-line
Utilization by shop code	On-line
Demand history	On-line
Vendor invoice	Auto-generated
Delivery manifest	Auto-generated
Receiving report	Auto-generated
Plant property report	Auto-generated
Vendor performance	Upon request
Vendor substitutions	Upon request
Vendor price changes	Upon request
Vendor delinquent orders	Upon request
Orders for local warehouse items	Upon request
Hazardous Material Report	Upon request
DD 1057 Report	Monthly

The major benefit of the SPEDI database is that it captures accurate real-time historical data. The benefits derived from the availability of such data range from determining precisely how much has been spent (for what items in which organizations) to providing accurate data for developing new requirements or budgeting purposes.

SUMMARY

The first SPEDI prototype contract for office supplies was awarded in October 1990. It took approximately 1 year to bring the contractor to a fully operational stage, during which time the hardware, software, and interfaces were demonstrated to be sound, as was the bar code technology.

In October 1991, a SPEDI Operations Division was formally established and staffed with 13 people. During its 1-year existence, the following has been accomplished:

1. A second SPEDI contract for automated data processing (ADP) peripherals ($2.1 million for 2 years) was awarded.

2. Teaming Partner Agreements (TPAs) were established with General Services Administration (GSA) contractors to supply ADP software.

3. A TPA with Hewlett Packard was brought on line under a GSA contract to supply electronic test and measurement equipment.

4. Three solicitations (paint, safety equipment, and research and development chemicals) are being prepared for issuance.

5. The option for office supplies has been exercised.

6. Work has been started on an electronics requirement.

NAWCWPNS purchases under SPEDI contracts and TPAs for FY 92 totaled over $3 million.

CONCLUSIONS

The purpose of any investment is to secure a future gain that, even though postponed, is sufficiently large to warrant the earlier sacrifice. NAWCWPNS spent just under $2 million to develop SPEDI software; this not only included the software development, but also the procurement support to issue the first prototype contract. The yearly operating cost of the SPEDI division (including contractor automation support) is $799,000. Successful implementation of the initial two contracts has proven that the concept is stable and that the software program

and its vital interfaces perform as designed. It was anticipated that by entering into longer duration contracts, which included greatly accelerated payment terms, quantity discounts of 10% would be attainable. Presently, the two contracts cited above are providing discounts that exceed 40%.

In addition to the cost savings, significant vertical benefits result. These include:

1. Vastly shortened procurement lead times in the design of new weapons systems, thereby lowering program schedule risks.

2. Reduced warehouse requirements and inventories.

3. Reduced manpower requirements.

4. Increased technology information flow.

5. Better vendor accountability and relationships.

6. Real-time data accumulation and availability.

In conclusion, the application of exchanging data electronically used in conjunction with today's bar code technology offers endless opportunities to improve business processes by better utilizing resources, accelerating transactions, and providing real-time data upon which to base critical decisions.

IS DARPA PREJUDICIALLY FAVORING THINKING MACHINES?

Jon R. Troyer, Grad. Asst., University of Dallas, GSM

ABSTRACT

Such a charge was leveled against DARPA by supercomputer manufacturers, so "sales don't come down to technology or software, [but] to someone playing God and saying we'll make it easier to work with one vendor."[i] Were it not for the timeliness of several issues raised by the question "Is Darpa Prejudicially Favoring Thinking Machines?" echoes of laughter would close discussion. The U.S. needs policies to spur innovation that are lacking in the current competition mandates.[1]

Can savings that are achieved only from innovation be exceeded by savings from the competitive selection of items which otherwise would not be manufactured? Assumptions of saving on the basis of competition are wrong. The appearance of favoritism is due to misunderstanding the nature of markets, which are arbitrary groupings, and failure to compare savings from competition to savings from innovation.

Congress "tends to think of itself as a body that not merely provides some services for an independently functioning order but 'runs the country' as one runs a factory or any other organization. Since it possesses authority to arrange everything, it cannot refuse responsibility for anything."[ii] Congressional distrust of sole-source profiteering should be more than counterbalanced by fears of subsidized stagnation, as savings from innovation are greater than savings from competition. Ironically, boosting competitiveness is done simply by repeal of the *Competition in Contracting Act,* because breakthrough thinking spurs growth.[2]

INTRODUCTION

This paper supports the enactment of an "Innovation In Contracting Act." The Innovation in Contracting Act key features are three forms of procurement, 1) innovative proposals, 2) sealed-bidding, and 3) catalogue purchases. The sealed-bid awards are priced by competition. The innovative proposals are priced by virtual competition because after five years the agency would be required to compete innovative items in a sealed-bid, and so fully market price the items. A Contract Renegotiation Board would be required to limit unit price during the five year period to less than three times the awarded open market price. This precludes any and all requirements for cost or pricing data. Multi-step sealed bidding will replace all competitive proposals, setting a market price by auction competing suppliers without cost analysis. Noncompetitive proposals, unsolicited proposals, sole-source awards, or any award where there is one innovative supplier are called innovative proposals.

---

[i] "Pentagon Unit Steers Supercomputer Deals to Certain Companies - Rival Firms Complain Darpa is Unfair in the Way It Stresses Parallel Processing - Agency that Hates Red Tape" (1991) *The Wall Street Journal,* 6 August, pp. A1,A6.

[ii] Hayek, F.A. (1973) *Law, Legislation and Liberty,* U. of Chicago Press, p. 143.

The purpose is to stimulate innovation beyond product differentiation, and reinforce careful thinking about markets. In short, the whole procurement process gains by opening the world to the radical departure of Darpa and Thinking Machines.

On its face, favored treatment by the government in any procurement could limit competition through the application bribes, and other conspiracies to defraud by using public office for private gain. In fact the adversarial environment of public procurement, makes this a remote, tenuous, even humorous charge.

Such a charge was leveled by supercomputer manufactures including Convex of Richardson, Texas, Cray Research, and NCube. They are lobbying for competitive bidding on supercomputer purchases, and accelerated purchase contracts. What emerges are issues bound to national security, the economic welfare of the U.S., and faulty federal procurement law. Defense R&D, the U.S. edge in high technology, is increasingly important so that drastic measures are not required if it is necessary to reverse the current drawdown. Competition Advocacy is doomed because it seeks to create sources, not to spur innovation, but only for the sake of obtaining two bids, which is more than one. Those who enter the market after R&D has been completed do not require incentive prodding, but restriction against using proprietary data and so dousing innovation.[3]

Now let's backup to examine Thinking Machines and Darpa, The Competition in Contracting Act of 1984, Competition and pre-competition, and then an analysis Innovation in Contracting applied to case law.

1. DARPA AND THINKING MACHINES

The prototype Connection Machine was funded under contract #N00039-84-C-0638. In the acknowledgements section of his dissertation Daniel W. Hillis gives tribute to "Craig Fields, who knew it was the right thing."[1] Recently Hillis announced a new machine that departs from the original conception, but which appears to be winner of the LINPACK WARS or race to develop a machine that exceeds a TeraFLOP.[4] Previously Thinking Machines announced surpassing nine GigaFLOPS.[5] Darpa made a $12 million award in 1989, at the same time awarding Intel $7.7 million.[6]

The Strategic Computing Program is program is duel purpose in the sense that the applications are both military and commercial.[7] NCube has complained about not getting a subsidy for a commercial customer.[8] The CM2 at Mobile R&D in Farmers Branch, and the Convex machine beside it were purchased without government support. Aeronautical design programs or battlefield programs have features common to seismic exploration programs. This is hardly venal. Darpa spends in excess to $100 million of its $1.5 Billion in the Strategic Computing Program.

Darpa was created by PL 85-325 responding to Sputnik.[9] Darpa programs include light satellites, graphics workstations, artificial intelligence, composite materials, digital gallium arsenide, high-density displays, global positioning system enhancements and anti-helicopter mines infrared beacons for Desert Storm, ultra wide-band (B-2 killing) radar. Darpa also developed the automatic teller machine and the PC mouse. The *X-31* National Space Plane is pioneering

[1] Hillis, W. Daniel. (1989) *The Connection Machine*, The MIT Press, 1989. Same as thesis (Ph.D.)-MIT, 1985.

new research frontiers. The Strategic Computing Program aims to solve the Grand Challenges including, "global weather prediction, determining atomic structures, under standing turbulence, mapping the human genome."[9]

Congress authorized "flexible agreements," and Craig Fields gave $4 million to Gazelle Microcircuits, which John Sununu new was the wrong thing. But the White House is softening on so called Industrial Policy, and the program appears to be continuing.[10]

The Darpa Initiative in Concurrent Engineering is an effort shorten time to production. The DOD has mandated the Computer-Aided Acquisitions and Logistics Support program (CALS) which includes data interchange and design tool specifications for improving acquisition and program support.[11] Concurrent Engineering poses a new opportunity to redefine cost or pricing data, especially for paper-driven bureaucracies. Ultimately, that is the last thing needed by an innovation fostering policy, and signals the end to the usefulness of acquisition cost or pricing data. Inclusion of work measurement system data mandates disclosure of measurements made for variance analysis, and how process planning, cost estimating, and productivity improvement is done as cost or pricing data. The courts may have the opportunity to read-in a legal definition of TQM when DCAA conspires with DCMC Quality Division for enforcement. What a great way to send Deming to his grave.[12] Roadblocks are eliminated.

2. COMPETITION IN CONTRACTING ACT FLAWED

CICA is flawed. Convex, Cray, and N-Cube maintain they are in the same market characterized by high-speed computing power. This is an arbitrary assumption. i.e. that competitors in LINPACK WARS comprise a market grouping. Supercomputers are not standardized or easily substituted. The differences between products amount to more than the differentiation between Chevy and the Cadillac. The grouping is convenient only from the stand-point decreasing consumer confusion, though the products "Consumer Reports" would make comparison much less sure. For instance the CM-2 was optimized for fine-grain parallelism, short words, many processors, and less memory per processor, while the Intel Machine optimized for fewer processors, wide words, and more memory per processor.[13,14,15] These vast differences mark more than differentiation, and question seriously whether they are in the same market.

A sealed-bid for supercomputers unravels another problem with CICA, and Comptroller General (Comp Gen) cases before it, specifications unduly restrictive of competition, but is resolved by understanding that markets are arbitrarily grouped.

A sealed-bid for the "Connection Machine or equal" would surely be found restrictive of competition, because everyone knows a supercomputer is one thing, a LINPACK measurement.

If the needs of an agency are clearly defined discriminating selections are a

---

[9] Mygatt, Matt. (1991) "Supercomputer experts gather to discuss their trade," *Startext*, 17 November. (William Comp, manager of mathematics and computational science, Los Alamos, further states, "We would like to help the U.S. industry become more competitive in the economy by helping them understand what we have learned.")

good practice. All that essential features and minimum needs buy are products void of specialized factors of production, the lowest common denominator, the most stagnant technology, the undifferentiated in a Freudian sense.

CICA fails to strongly emphasize that the foundation of procurement is well written specifications. Cibinic considers specifications the "cornerstone of competitive procurement."[i] Well written, specifically defined specifications lead to fair evaluations of subjective factors, because the factors are well understood by all competitive bidders, called the market. Well written specification lead to fair evaluation of innovative subjective factors which are well understood by one supplier, called the pre-market or pre-competition.

If the needs of an agency are clearly defined it is an unfortunate misunderstanding of markets to find that the agency's minimum needs have been overly restrictive of competition. That is based on an arbitrary market grouping, and death to innovation. Poorly written solicitations leave no doubt as to market ignorance. Well written specifications lead to fair evaluations of subjective factors, because the factors are well understood by all bidders.

Why is Competition important? Former Vice-President Quayle was head of the Competitiveness Council, so maybe its not.[16] Actually Quayle as a Congressman signed a letter to the DOD which softened DOD implementation of CICA regarding R&D money.[3] Competition is important to achieve the best possible utility for the buyer and the seller. Competition is an auction where buyers and sellers reverse the traditional role to gain the best bargain possible which the lowest transaction costs. The consumer and supplier surplus, the excess gain of utility over the final bargain is wasted by competitive proposals, obliterated by huge transaction costs. Although competitive proposal were brought to the same legal standing as seal-bids the economic differences are not reduced. But even Milgrom plays the tune of "possibilities for influence, favoritism, and bribes" as if Fields must be swimming in filthy kick-back lucre.[ii]

More than one proposal defining approaches to the identical requirement is competitive. In the five years after CICA competitive procurements amounted to less than forty percent of all DOD contract dollars.[17] This indicates poorly defined requirements, and huge economic losses on sole-source procurement which rely on virtually no market prices. Generally, government cost-price analysts are loathe to use pricing analysis. (Because they receive taxpayer back-breaking gratuities?)

The CICA provision that all unsolicited proposals be market tested has set a policy ruinous to innovation, and for the flimsy reason that agencies may be flooded with proposals protected from competition.[18]

The result is that a contracting officer will put proprietary, or slightly disguised proprietary ideas and innovations out on the street. Nothing could scuttle innovative ideas faster.

After understanding the essentially arbitrary nature of markets, strictly speaking every manufacturer could make the

---

i (1982) Senate Report no. 98-50. *USCCAN 89-2*, p. 2187.

ii Milgrom, Paul. (1989) Auctions and Bidding: A Primer, *Journal of Economic Perspectives*, Vol. 3, No. 3, Summer, pp. 3-22. (Analysis of "Winners Curse," when you win, you lose.)

previously feared "unique and innovative" claim for protection from competition. But hypothesize that the Contracting Officer is not required to market test unsolicited proposals. A and B both make proprietary claims for items that are easily substituted, and the Contracting Officer cannot put these on the street. What does he do? He competes A against B behind closed doors, and entertains bids/proposals by easily substituted X, Y, Z. He picks the best one of the five resulting in no impact on cost. Therefore, this provision is unreasonable. And by blocking innovation the provision for market testing of unsolicited proposals is disastrous.

Stimulating innovation is a legitimate policy. Innovation is savings. Dr. David Gordon, U. of Dallas, "You are worse off to spend money on a system if the systems really should not be produced in the first place." To many companies are kept busy protecting there markets, or asking regulators to keep them profitable, and so innovation is kept a low priority. The competitive advantage derived from innovation springs from up-grading a process or procedure so that it realizes efficiency which is difficult to duplicate.[19,20] This should be heartily encouraged in all fields of endeavor, among numerous companies. A truly better widget develops the firm's and the countries resource base. Better there be more innovative contracts than competitive ones, and for more dollars, to drive down costs. Darpa successfully does this in many advanced programs, but that is only the tip of the ice-berg. Describing the latest function, Lee Buchanan director of the Defense Sciences Office at Darpa, is sufficiently fearful of consequences, "Darpa is not consciously acting as a venture capitalist, although it would appear that we are to the company involved because we will participate in their profits. However, Darpa will not control stock, will not be involved in the management of the business and will not be involved in setting industrial policy."[I] He is following the same Congressionally funded program which lead to Field's departure.

Rather than creating separate agencies and functions to support innovation, mandate it across the board. These ideas are elegantly expressed by Porter who calls for policy to transcend to a "higher plane,"[II] and signals the resolution of the Industrial Policy Debate, which we redefine in terms of competition and pre-competition.

3. PRE-COMPETITION

The free-marketers and the interventionists are equally wrong, but what are they saying. Free-marketers are against government planning, rent control,[21] wetlands management,[22] protectionism, and cartels that protect the inefficiency of big companies. Interventionists like to say MITI Japanese government subsidies account for Japanese success, and that cooperative programs, tax incentives, and loan guarantees will solve the riddle of competitiveness (outselling the Japanese.)[23]

Craig Fields now works at Microelectronics and Computer Technology Corp. in Austin, where he hopes to prove that public money ($100 million) for advanced research can improve the economy.[24] His "retirement" from government service (April 1990) was seen as a victory for the free-marketers.[25] But in March 1990 Bush had promised support for both commercial and defense research. HDTV, with wide

I Henderson, Breck W. (1991) "Darpa Invests $4 million As Venture Capital in High Technology Companies," *Aviation Week and Space Technology*, 30 April, p.25.

II "Industrial Policy" (1992) *Business Week*, 6 April, p.73.

commercial application, is currently funded by Darpa for $70 million.[26]

Commercial spin-offs from military research are under-whelming.[27] The National Institute of Standards and Technology (NIST) was established from the old National Bureau of Standards in 1988, and has some Darpa-like commercial functions, but is under-funded.[26] The National Science Foundation (NSF) supports basic research but there has been a call for a separate agency to support productivity research "virtually ignored and left to the business schools."[i] It is under-educated.

Most military R&D is allocated to specific weapons programs, and as those programs decline, the R&D declines faster. If military and commercial advanced technologies are the same, less military research also means less commercial research, and the point is that the decline in military research should be mirrored by increased commercial spending. As defense declines, NIST and NSF should increase.[28]

It is possible that government spending on basic research diverts a given companies attention from crucial proprietary research, but the trade-off is an increase in the range of improvements and special knowledge of the factors of production, a subsidy for the shot-gun approach to innovation called pre-competition at the national level.

The government has the responsibility to provide a technically current economy, so that its autonomous or self-directed citizens can successfully execute their plans. *Laizez-faire* needn't be a tyrant, nor Industrial Policy the end of individualism. If you are autonomous, you innovate, and conversely, depending in great part on the contracting capabilities.[29,30,31]

4. INNOVATION IN CONTRACTING V. CASE LAW

"We now have a new statutory approach as well as statutory codification of competitive concepts developed over the years by the Comptroller General," Doke.[ii]

Starting with this well informed judgement (*sui generous* a fact for students of mumbo-jumbo cost or pricing data) of CICA's arrival, let's see if the proposed Innovation in Contracting Act would sit well with case law (authority). All the cases are from Nash and Cibinic.[iii] To reiterate the key features of IICA it includes three forms of procurement, 1) innovative proposals, 2) sealed bid, and 3) catalogue purchases. The sealed-bid awards are priced by competing bidders. The innovative proposals are priced by virtual competition because after five years the agency would be required to compete innovative items in a sealed-bid, and so market price the items. A Contract Renegotiation Board would be required to limit unit price during the five year period (generous because product cycles are now less than three years) to less than three times the open-market price. This precludes any and all requirements for cost and pricing data. Catalogue purchase rules follow commercial practices (*UCC*).

i Brinkman, W.F. (1990) "A National Engineering and Technology Agency." *Science*, February, p. 901. (From the scrap heap of science.)

ii Doke, Marshall J., Jr. (1985) "Recent Legislative Developments in Government Contracts," 30 January. (Subjective evaluation factors may allow selectivity/caprice by agencies.)

iii Nash and Cibinic (1976) *Government Contract Law*, George Washington University, pp. 193-381.

Contractor burdens continue to include responsiveness and responsibility. Government burdens of full and fair competition are altered to induce innovation, to stimulate growth. Clarity of specs is emphasized. Other than the following judicial authority, Comp Gen included, are at times made defunct by subsequent statutes.

Contractor Responsiveness

The Comptroller General rule is that as long as substance (price, quantity, quality) is unchanged, deviations are allowed. Statutes disallow acceptance of non-responsive bids. Because it is likely that more sealed-bids will be done, and responsiveness is required in sealed-bids, responsiveness will gain a higher profile. Responsiveness in the case of innovative proposals, would, like the present non-competitive awards, not be formally required. Prestex v. USA (1963).

Determinations of responsiveness must be in the government's best interest and without prejudicial favoritism. In responsiveness disputes, sadly, charges of favoritism will remain a factor under IICA. Comp Gen B-148624 (1962).

Proof of reliability would continue to be included as a responsiveness determination, separate from predicting responsibility. Though responsiveness is not an issue of innovative proposals, like negotiated proposals, proof of a proposed products capability should be demonstrated. Comp Gen B-175492(1) (1972).

The necessity for substantial work to upgrade a proposal to level of responsive which can be a finding of non-responsiveness could be the source of an end-run should the contractor be able to show that the contract contemplated was obsolete and though not responsive to the contemplated action could perform the agencies needs under an innovative proposal. Possible if basic specs are exceeded or somehow themselves obsolete. Innovative proposals could easily begin with the Non-Inclusive clause which states nothing shall prohibit the agency finding another method to achieve the contemplated goals of the solicitation. PRC Computer (1975).

The computation of weighting factors which are misleading, or that reflect that more than price is at issue, or that change the specs to upgrade for responsiveness without telling all bidders, indicate an arbitrary decision. Setting a market price is the goal in sealed-bidding, but there are many pitfalls. Arbitrary abuse of authority is disputable in the contractor's world and would continue to be. Bell Aerospace (1975).

Contractor Responsibility

The contracting officer has the duty to resolve inconsistencies and uncertainties regarding responsibility. Successful protest of Contracting Officer non-responsibility finding. For sealed-bid this is the same, and it would be a requirement for innovative proposals. Comp Gen B-172061 (1973).

There must be some evidence the contractor is responsible. It is possible to protest Contracting Officer affirmative finding of responsibility, though less likely of success than the protest of the negative finding above. Responsibility is a factor under any scheme, no change for IIC. Data Test Corp. (1975).

Government Specification

A mixture of performance specs and detailed technical specs caused confusion

to competing parties. Specs should be well-written. Without careful purchase planning sealed-bids and innovative proposals are useless. Contractors should always be given the opportunity to clarify specs. Sealed-bids should be conducted so that there is ample opportunity to clarify specs. Comp Gen B-175585 (1971).

Actual requirements must be present in an auction, or innovative proposal. If there is indecision about what criteria are to be applied there can be no mutuality of agreement let alone competition or innovation. Refining Associates v. USA (1953).

There must be certainty as to what price is actually being bid in a sealed-bid. It should be possible to include all contract types under sealed-bids, if it is commonly understood what is being bid on and commonly understood what the price bid is. Comp Gen B-178192 (1973).

Two-step sealed bidding should enjoy a revival, especially where a highly specialized process has been achieved by a larger group of competitors (gains from innovation are not generally an infinity, e.g. Mrs. Baird's Bread, or the CM-2 five years hence.) It would be unfair if bidders were bidding on different solicitations. Comp Gen B-178192 (1973).

The specs cannot be altered, unless they are waived for all bidders, which means the prospective agreement is changed. Again all bidders must be bidding on the same thing. Alteration of an innovative proposal must also be specific about changes to maintain clear understanding of the program. Corbetta Const. (1976).

Competition Rulings

The requirement for meeting minimum needs so as to maximize competition, should be recast so as to maximize innovation while fulfilling the agency's needs. Minimum needs are not discriminating needs, but only needs essential to agency requirements. In contrast IIC would make meeting discriminating needs a top agency priority. This purchase would be a simple catalogue purchase, pre-priced. Comp Gen B-164993 (1968).

Performance requirements should be accessible and inclusive, without "brand-name or equal" which is restrictive of competition. The finding is based on specs which were adequately defined. "Brand-name or equal" is only appropriate where there are not good specs available. It should never be appropriate. Comp Gen B-166849 (1969).

Competition is not unreasonably restricted because some cannot meet requirements. Responsiveness and responsibility determinations must be made in good faith. The sections above described the responsiveness and responsibility burdens on contractors. Comp Gen B-175254(1) (1973).

Legitimate needs must not be compromised to obtain competition, but if no development is required and items are off-the-shelf, solicitations must be made available. Under IIC the requirement for Fluke-meters would have automatically been bid competitively in five years, or simply ordered from the Fluke catalogue. Non-Linear Systems (1975).

5. ASK CRAIG FIELDS

If challenges to arbitrary abuse of authority were also disputable within government ranks, if there existed an equitable estopple to uphold wavering reliance, and reverse official mismanagement, government worker-bees would halt many inequities before they had to be moved to a another jurisdiction. According to Dan Riley, Adjunct Professor at the U. of Dallas, and Partner in the law firm Doke and Riley, "Estopping the government without a contract is ... difficult." That is the century's understatement. Ask the conscientious Craig Fields or his supporters about sovereignty not held accountable by the arm's length contract.[32]

From the stand point of current law, ruinous to innovation, Fields did not simply extend prejudicially favoring terms, Fields held Hillis above the law, and Fields was later punished foı similar action. But rather than shining a light on a corrupt procurement, the story illuminates the gross inadequacy of current law. It is the mission of Darpa to stimulate advanced research, but because innovation should be the preoccupation of every company, not just Hillis', and at the core of every contract, these lessons must gain wide subscription, mandated.

SUMMARY

Because of the value of expectations, the spirit and bone of a new century begins a decade prior. The world wide recession with global consolidations tells us our first breaths of the 21st Century are best symbolized by walking pneumonia.

Innovation in Contracting sends the message that saving by innovation gets priority. It also pays a market price. The use of cost or pricing data is inferior, and destroys autonomy, by saying that though we trust you to build point, click, and kill in N+1 dimensions, we just don't trust you with $2.50.

BIBLIOGRAPHY

1 *Competition in Contracting Act of 1984. (1985) Title VII of Division "B." of the Deficit Reduction Act of 1984,* P.L. 98-369, 98 Stat. 494. Reprinted in *Government Contract Guidebook, Federal Publications: 1986,* pp. APP-1 to APP-31.

2 "Industrial Policy." *Business Week,* 6 April, pp. 70-75.

3 Williams, Early C. (1987) "CICA and Other Threats to America's R&D Base." *Contract Management,* December, pp. 16-19.

4 Yenkin, Jonathan. (1991) "Company unveils new style of supercomputer." *Startext,* 29 October.

5 "Thinking Machines Retakes Title for Fastest Computer." (1991) *The Wall Street Journal.* 5 June, p. B-3.

6 "These Machines Would Make Supercomputers Look Slow." (1989) *Business Week,* 18 December, p. 87.

7 Kuttner, Robert. (1990) "Industry Needs a Better Incubator than the Pentagon." *Business Week,* 30 April, p. 16.

8 Schatz, Willie. (1989) "U.S. Computer Research's Basic Dilemma." *Datamation,* 1 December, pp. 44-47.

9 U.S. Government. (1984) *U.S. Government Purchasing and Sales Directory,* U.S. Small Business Administration, Office of Procurement and Technical Assistance.

[10] Bylinsky, Gene. (1991) "Darpa: A Big Pot of Unrestricted Money." *Fortune*, Spring-Summer, p. 65.

[11] Rosenblatt, Alfred, and Watson George F. (1991) "Concurrent Engineering." *IEEE Spectrum*, July, pp. 22-37.

[12] *U.S.C.A.* (1991) *Title 10 Armed Forces SS 2406 Availability of cost and pricing records*, pp. 358-360.

[13] Intel. (1991) "Toward TeraFLOP Performance: an Update on the Intel/Darpa Touchstone Program." Supercomputer Systems Division, November.

[14] Thinking Machines Corporation. (1990) *Connection Machine Model CM-2 Technical Summary.* Version 6.0, November.

[15] Troyer, Jon R. (1991) "Thinking Machines CM-2 and Intel IPSC/860 Contrasted." A Seminar Report submitted to Professor Sanyal, University of Dallas, Graduate School of Management, July.

[16] Kranish, Michael. (1991) "Quayle's review of regulations affecting business seen a menace." *Startext*, 15 November.

[17] U.S. Government. (1991) "DOD's Competition Reports to the Congress Could Be More Clear." General Accounting Office, July.

[18] Senate Report NO. 98-50. *USCCAN 89-2*, p. 2217-2218.

[19] Porter, Michael E. (1990) "The Competitive Advantage of Nations." *The Harvard Business Review*, March-April, pp. 73-93.

[20] Grant, Robert M. (1991) "The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation." *California Management Review*, Spring, pp. 114-135.

[21] Baird, Charles W. (1980) "Rent Control: The Perennial Folly." *Cato Public Policy Research Monograph No. 2.*

[22] Kranish, Michael. (1991) "Quayle decision to relax wetlands definition is most controversial." *Startext*, 15 November.

[23] "Better at quibbling than galloping." (1989) *The Economist*, 16 December, pp. 21-22.

[24] Carey, John and Bartimo, Jim. (1990) "If You Control ... Computers, you control the world." *Business Week*, 23 July, p. 31.

[25] "Beheaded." (1990) *The Economist*, 28 April, pp. 27-28.

[26] Marshall, Eliot. (1991) "NIST: High Command for Industrial Research?" *Science*, 5 April, pp. 20-24.

[27] Perry, Nancy J. (1991) "More Spin-offs From Defense." *Fortune*, Spring-Summer, pp. 60-65.

[28] Norman, Colin. (1990) "Defense Research After the Cold War." *Science*, 19 January, pp. 272-273.

[29] Smith, Rodgers M. (1985) *Liberalism and American Constitutional Law*, Harvard University Press.

[30] Peters, Tom (1990) "Part One: Get Innovative or Get Dead." *California Management Review*, Fall, pp. 9-26.

[31] Peters, Tom (1991) "Part Two: Get Innovative or Get Dead." *California Management Review*, Winter, pp. 9-23.

[32] "Political Crossfire at Darpa." (1990) *Aviation Week & Space Technology*, 30 April, p. 9.

COST AND SCHEDULE EXPERIENCE FOR GROUND COMBAT AND SHIP ACQUISITION PROGRAMS

Karen W. Tyson, Neang I. Om, D. Calvin Gogerty, and J. Richard Nelson,

Institute for Defense Analyses

This paper highlights the cost and schedule experience of programs to acquire ground combat systems and ships since the 1960s. This is important, because it gives us a picture of the effectiveness of acquisition policy for these groups of equipment over time.

Ground combat programs include military vehicles and a set of distinctive Army programs. The Navy ships and related acquisition programs comprise three combat data systems, ten classes of surface vessels, and two classes of attack submarines.

We will see that the two groups of systems had dramatically different cost and schedule outcomes. In order to explain the differences, we examined whether management initiatives resulted in more favorable outcomes for each group of systems. We also considered distinctive features of the two program groups that might account for the differences.

I. DATA

We obtained information on development and production costs and schedules and IOC dates from the Selected Acquisition Reports (SARs) for each program.

For some ground combat systems that have multiple major modifications (e.g., Bradley FVS) or multiple subsystems [e.g., rocket and launcher for the Multiple-Launch Rocket System (MLRS)], the SAR does not have development cost nor production cost reported by modification version or by rocket and launcher. In these cases, we obtained the breakdown of production costs by version and subsystem from the Army Cost and Economic Analysis Center (CEAC). For surface-launched munitions systems (e.g., MLRS), price improvement curves for the current estimate of production cost at Development Estimate Quantity were developed by launcher, rocket, and practice rocket and added together to obtain the total production cost. In the case of the ships, we supplemented the SAR data with information supplied by the Navy Center for Cost Analysis and with data from technical references such as *Jane's Fighting Ships*.

Development or current estimates of production costs for the air defense and submarine combat systems could not be determined from the SARs. Any production cost data shown in the SARs for those programs are for support equipment. The actual production costs for those programs are included in the production costs for the ships in which they are installed, and those costs cannot be broken out separately from the SARs for the ships.

Cost growth is defined as the percentage by which actual cost exceeds estimated cost. (Negative growth is, of course, possible, if the actual turns out to be less than the estimate.) In development, actual cost is measured from the beginning of development to the end of development of the first version of the system. In production, actual cost is adjusted for quantity change, by means of a price improvement curve.

Quantity growth is defined as the percentage by which actual quantity exceeds planned quantity, while schedule growth is defined as the percentage by which the actual schedule exceeds the planned schedule. The development schedule is defined as the number of months from Milestone II to IOC, while the production schedule is defined as the number of months from Milestone III to the end of the production run for the first version of the system.

Information on the acquisition program initiatives applied to each of the programs was obtained from the SARs and from questionnaires submitted to the program managers. The measures of effectiveness were then compared to determine the effectiveness of the acquisition program initiatives.

II. GROUND COMBAT PROGRAMS

We selected nine ground combat programs to include in our analysis: three surface-launched tactical munitions platforms, one surface-launched artillery, three armored vehicles, one intelligence processing system platform, and one field artillery. The programs are listed in Table 1.

Table 1. Ground Combat Programs

Program	Type	New or Modification	Quantity	Producers
FAADS LOS-R (Avenger)	Surface-Launched Tactical Munition	New	1,207	Boeing Aerospace Co.
Sgt. York (DIVAD)	Surface-Launched Tactical Munition	New	64	Ford Aerospace and Comm Corp.
MLRS	Surface-Launched Tactical Munition	New	4,813	LTV Aerospace and Defense Company
Roland	Surface-Launched Tactical Munition	New	27	Hughes Aircraft Co. and Boeing Aerospace Co.
M1 Abrams Tank	Armored Vehicle	New	2,488	General Dynamics
Bradley FVS	Armored Vehicle	New	2,300	FMC Corp.
M60A2	Armored Vehicle	Mod	543	Chrysler Corp.
ASAS/ENSCE	Intelligence Processing System	Mod	N/A	Jet Propulsion Laboratory
M198 155mm Towed Howitzer	Field Artillery	New	584	Rock Island Arsenal

Five of the nine systems are still in production. The earliest program started full-scale development in 1970 and began production in 1976 (M198 155mm towed howitzer). Two armored vehicle programs, the M1 Abrams tank and the Bradley Fighting Vehicle System (FVS), started full-scale development in 1976, started production in 1979 and 1980, and are still in production. These two programs underwent two and three major modifications respectively after they were developed.

We included two programs that were terminated due to cost and performance problems, Roland and Sgt. York (DIVAD). Median development time for ground combat programs is 85 months. The production time span has a median of 69 months, including the projected time for programs that are still in production. Ground combat programs' development and production start dates, the initial operational capability (IOC) and projected production end dates are shown in Table 2.

Table 2. Development and Production Times for Ground Combat Programs

Program	FSD Start	IOC	Dev. Time (in months)	Prod. Start	Prod. End	Prod. Time (in months)
FAADS LOS-R (Avenger)	Nov-86	Sep-89	34	Aug-87	Sep-97	121
Sgt. York (DIVAD)	Nov-77	Mar-87	112	May-82	Sep-85	40
MLRS	Jan-77	Mar-83	74	May-80	Sep-94	172
Roland	Jan-75	Jul-84	114	May-79	Sep-81	28
M1 Abrams Tank	Nov-76	Jan-81	50	Apr-79	Sep-83	53
Bradley FVS	Nov-76	Dec-83	85	Feb-80	Sep-84	55
M60A2	Mar-65	Sep-74	114	Mar-68	Sep-73	66
ASAS/ENSCE	Dec-84	Apr-89	52	Mar-87	Sep-06	234
M198, 155mm Towed Howitzer	Dec-70	Apr-79	100	Dec-76	Sep-82	69
Mean			82			97
Standard Deviation			31			69

In this section we describe our analyses of ground combat programs in three areas: distinguishing features, program outcomes, and effects of acquisition initiatives on program outcomes.

1. Distinguishing Features of Ground Combat Acquisition Programs

Three features distinguish the ground combat acquisition programs from the other acquisition programs:

1. Larger numbers of units are generally produced relative to other types of weapon systems. The lowest quantity to be produced in the ground combat programs (excluding the two canceled programs) is 543.

2. The use of accelerated acquisition strategies in order to field the system as quickly as possible led to several practices: (a) concurrent development and production before operational and evaluation test completion (Sgt. York, Roland, M60A2), (b) procurement of nondevelopmental items (FAADS LOS-R, ASAS/ENSCE), (c) procurement of a system with limited capability configuration (ASAS), (d) limited urgent procurement (ASAS). These practices contributed to high growth in cost, delays in schedules, reduction in performance levels (Roland), and acquisition of systems that could not meet performance requirements without major modifications (Sgt. York, M60A2, FAADS, ASAS/ENSCE).

3. On average, the ground combat acquisition programs have higher development schedule and development and production cost growth than other systems. Most of the ground combat acquisition programs examined here took place when military spending was in an upward trend. Perhaps the cost and schedule problems in this set of programs occurred because industry had to add capacity to meet demand. Another potential reason for the problems is the lack of commonality between ground combat program subsystems.

2. Outcomes of Ground Combat Acquisition Programs

Measures of acquisition program outcomes for the ground combat programs are shown in Table 3.

Table 3. Outcome Measures for Ground Combat Programs

Program	Development Schedule Growth	Development Cost Growth	Production Cost Growth	Stretch	Total Program Cost Growth
FAADS LOS-R (Avenger)	0	5	N/A	N/A	N/A
Sgt. York (DIVAD)	15	29	216	371	203
MLRS	6	2	-12	4	-8
Roland	115	52	383	187	319
M1 Abrams Tank	-6	54	36	-39	40
Bradley FVS	23	216	259	-48	250
M60A2	217	28	121	-1	115
ASAS/ENSCE	49	49	N/A	N/A	N/A
M198 155mm Towed Howitzer	30	35	29	2	31

The Bradley FVS has the highest development cost growth of the ground combat programs. That is probably because that program inherited its engineering development and funding from the troublesome Mechanized Infantry Combat Vehicle (MICV) program, which was terminated after five years in development. The MICV problems included failure to meet system weight specifications (approximately 1,000 pounds heavier), and performance requirements, such as reliability and durability, which resulted in design changes, hence, high cost growth.

There is enormous variability in production and total program cost growth among the ground combat programs. M60A2 and Roland had

performance problems and design changes, the cost effects of which were aggravated by concurrency in development and production. Both Sgt. York and Bradley failed to meet performance requirements, Sgt. York due to its accelerated acquisition strategy, and Bradley due to the addition of more advanced technology. The MLRS program, on the other hand, actually came in under its cost estimate.

Development schedule growth for ground combat programs is high, 50 percent. In specific cases, this high growth was due to concurrency of system development and production, system failure to meet performance requirements (e.g., M60A2 and Roland), and system design restructure during the development phase (e.g., M198 155mm howitzer). Lower production schedule growth is partly due to the cancellation of two programs out of nine in the sample (Roland and Sgt. York) after only three years in production. Also for the Bradley FVS and the M1 Abrams Tank, only original versions are considered for the analysis—that is, the systems in production were modified to a new version before production reached the quantity planned. Production quantity growth is much lower for the same reason.

3. Effects of Acquisition Initiatives on Ground Combat Program Outcomes

Six acquisition initiatives have been applied to different ground combat programs in various combinations. These initiatives are:

- Prototyping—five programs;
- Competition—three programs in advanced development, four programs in full-scale development (FSD), no programs in production;
- Multi-year procurement (MYP)—two programs;
- Design-to-cost (DTC)—four programs;
- Contract incentives—four in FSD, and three in production; and
- Firm fixed-price development (FPD)—one program.

The total package procurement initiative was not applied to any ground combat program. Acquisition initiatives in ground combat programs are shown in Table 4.

We examined Pearson correlation coefficients of the 1/0 variables representing the acquisition initiatives with the outcome measures. There are only two relationships of even borderline statistical significance: MYP is negatively correlated with PCG (significance level=.11) and TPCG (.09), and incentive contracting in production is positively correlated with PCG (.11) and TPCG (.10). In general, aside from MYP, initiatives found to be effective in other programs do not seem to have the same effect here. To some extent, this may be because of a small sample size and the unique problems of the ground combat programs.

In addition, the variability of program outcomes is high. When we examine averages, one program such as Roland may skew the results. When we omit the two programs that did not engage in any substantial production (Roland and Sgt. York), there are no significant correlations between the initiatives and the outcome measures.

Nevertheless, our small sample size allows us to look more closely at specific programs. While the relationships revealed by doing this are not statistically significant, they are often interesting.

a. Prototyping

Development cost growth in prototyped ground combat programs is higher than in non-prototyped programs. However, production cost growth is lower, an indication that prototyping may have some beneficial effect (Figure 1). The mechanism for this benefit appears to be the following: prototyping results in less development schedule growth (an average of 20 percent for prototyped vs. 48 percent for non-prototyped). Prototyped programs reach IOC closer to their planned times. We have seen that development schedule growth is a key driver of cost growth in production. This better adherence to schedule may help programs to avoid the trap of technical revision and stretchout that have plagued ground combat programs.

Table 4. Acquisition Initiatives Applied in Ground Combat Programs

		Competition			Multi-year
Program	Prototype	Adv. Devel.	FSD	Production	Procurement
FAADS LOS-R (Avenger)	No	Yes	Yes	No	No
Sgt. York (DIVAD)	No	No	Yes	No	No
MLRS	Yes	Yes	Yes	No	Yes
Roland	No	No	No	No	No
M1 Abrams Tank	Yes	No	Yes	No	No
Bradley FVS	Yes	Yes	No	No	No
M60A2	No	No	No	No	No
ASAS/ENSCE	Yes	No	No	No	No
M198, 155mm Towe Howitzer	Yes	No	No	No	Yes

			Contract Incentives	
Program	Design-to-Cost	Fixed-Price Dev.	FSD	Production
FAADS LOS-R (Avenger)	No	No	No	No
Sgt. York (DIVAD)	Yes	Yes	No	Yes
MLRS	Yes	No	Yes	No
Roland	No	No	Yes	Yes
M1 Abrams Tank	Yes	No	Yes	Yes
Bradley FVS	Yes	No	No	No
M60A2	No	No	No	No
ASAS/ENSCE	No	No	No	No
M198, 155mm Towe Howitzer	No	No	No	No

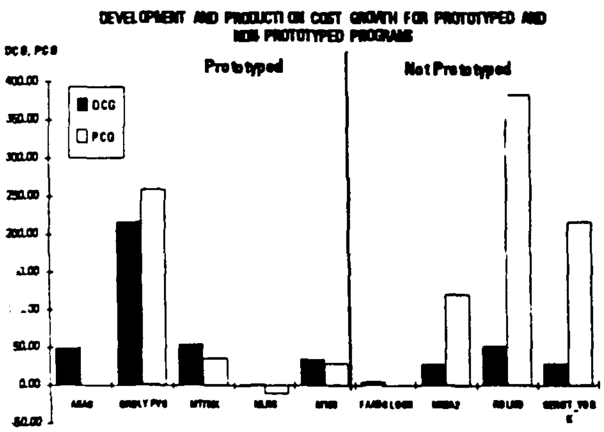


Figure1. Outcome Measures for Programs With and Without Prototyping

b. Competition

Dual-sourcing in production was not applied to any of the ground combat programs we are examining here. There are, however, four programs—the M1, FAADS LOS-R, MLRS, and the Sgt. York—that had more than one prime contractor involved in the full-scale development phase. Outcomes for these programs compare generally favorably with those that did not have competition in FSD (average total program cost growth of 16 percent vs. 132 percent), but the impact is not statistically significant.

c. Multi-year Procurement

Only two ground combat programs in our study—MLRS and the M198 howitzer—used multi-year procurement (MYP). The Bradley and the M1 had multi-year contracts, but they were applied to later versions than the ones examined in this study. The two multi-year programs had considerably better production outcomes than the rest of the sample. The average production cost growth was 8 percent for the two MYP programs vs. 139 percent for the other ground combat programs. As with other equipment types, the multi-year commitment protected the

programs from and thus helped to prevent production cost growth.

d. Design-to-Cost

For the design-to-cost (DTC) initiative, we have four ground combat programs with DTC (MLRS, Bradley FVS, Sgt. York, and M1 Abrams tank) and five without. DTC seems to affect production cost growth, although the relationship is not statistically significant. It has mixed results in controlling cost for the Army programs: successful for the MLRS and the M1, unsuccessful for the Bradley. For the MLRS, DTC was implemented in combination with other initiatives such as prototyping, competition in both advanced development and FSD, multi-year procurement, and contract incentives. For the M1 (original version), DTC was implemented in the program with prototyping, competition in FSD, and contract incentives in both FSD and production. DTC was claimed by both program offices to have been very effective in controlling cost and serving as a good design tool. For the Bradley (original version), DTC was applied with prototyping and competition in advanced development, but was dropped from the program as it progressed due to the product improvement program. The Army kept improving the system with additional technologies, which led cost to rise higher than DTC goals. Even for the original version of the Bradley, DTC goals were not met.

e. Firm Fixed-Price Development

Only one ground combat program used firm fixed-price development (FPD), the Sgt. York gun system. The weakness of FPD in the Sgt. York program was probably due both to difficulty with the technical performance of the system and to the limited resources available to the contractor. While the development cost outcome for the Sgt. York looks good, the program was highly concurrent, and the production cost growth was very high. Development problems spilled over into production.

f. Contract Incentives

The results on contract incentives are skewed by the presence of two failed programs. The technical shortcomings of the Roland and the Sgt. York probably cannot be blamed on incentive contracting. The only other program with incentive contracts in both development and production was the M1 tank, and its results are about in the middle of the other ground combat programs. Bradley and MLRS had incentives in development only—cost growth was high for Bradley and low for MLRS. From this evidence, we can see no consistent pattern of impact of incentive contracting in ground combat programs.

III. SHIPS AND RELATED NAVY PROGRAMS

Fifteen ship programs were the focus of this portion of the analysis: three combat data systems, ten classes of surface vessels, and two classes of attack submarines. The programs are listed in Table 5. The three combat data systems are being produced by two different companies. Nine different shipyards have been used to produce the ten classes of surface ships, and two different shipyards are being used to produce the two classes of submarines. Four of the ship classes are modifications of previous ship classes.

Table 5. Ship Programs

Program	Class	Type	New/Mod	Quantity	Producers
AEGIS	—	Air defense system	New	65	General Electric (RCA)
AN/BSY-1	—	Submarine combat system	New	NA	IBM
AN/BSY-2	—	Submarine combat system	New	31	General Electric
SURTASS/ T-AGOS	Stalwart	Ocean surveillance	New	18	Tacoma Boat Building, Halter Marine
CG-47	Ticonderoga	Surface combatant	Mod of DD-963	27	Bath Iron Works, Litton/Ingalls
DD-963	Spruance	Surface combatant	New	31	Litton/Ingalls
DDG-51	Arleigh Burke	Surface combatant	New	38	Bath Iron Works, Litton/Ingalls

FFG-7	Oliver Hazard Perry	Surface combatant	New	51	Bath Iron Works, Todd/ Seattle, Todd/San Pedro
LHA-1	Tarawa	Amphibious warfare	New	5	Litton/Ingalls
LHD-1	Wasp	Amphibious warfare	Mod of LHA	6	Litton/Ingalls
LSD-41	Whidbey Island	Amphibious warfare	Mod of LSD-36	8	Lockheed, Avondale
LSD-41CV	Harpers Ferry	Amphibious warfare	Mod of LSD-41	6	Avondale
SSN-21	Seawolf	Attack submarine	New	9	General Dynamics/ Electric Boat, Newport News
SSN-688	Los Angeles	Attack submarine	New	62	General Dynamics/ Electric Boat, Newport News
TAO-187	Henry J. Kaiser	Replenishment oiler	New	18	Avondale, Penn Shpbldg/ Tampa Shpyd

The dates each of the systems started development and production, along with the initial operational capability dates and projected production end dates, are shown in Table 6.

Table 6. Development and Production Start and End Dates for Ship Programs

Program	Class	FSD Start	Production Start	IOC	Production End
AEGIS	—	12/69	1/78	9/83	FY01
AN/BSY-1	—	9/83	N/A	3/90	N/A
AN/BSY-2	—	2/88	12/95	5/95	FY99
SURTASS/T-AGOS	Stalwart	10/74	5/77	8/83	FY87
CG-47	Ticonderoga	1/78	1/78	9/83	FY94
DD-963	Spruance	6/70	6/72	6/77	2/83
DDG-51	Arleigh Burke	12/83	10/86	2/92	FY01
FFG-7	Oliver Hazard Perry	12/83	10/86	2/92	FY01
LHA-1	Tarawa	4/69	1/71	5/77	FY81
LHD-1	Wasp	7/82	6/83	10/90	FY98
LSD-41	Whidbey Island	11/78	1/81	2/86	FY92
LSD-41CV	Harpers Ferry	12/87	11/89	10/90	FY99
SSN-21	Seawolf	6/85	6/88	5/95	FY99
SSN-688	Los Angeles	11/68	1/71	11/76	FY97
TAO-187	Henry J. Kaiser	12/81	11/82	2/87	FY94

Note: N/A means that data were either not available or insufficient.

1. Distinguishing Features of Ship Acquisition Programs

There are several features which distinguish the ship acquisition programs from the other acquisition programs. The first is that there are generally low numbers of units produced with very high unit costs. The greatest quantity to be produced in any of the ship programs is 65, and the median for the fourteen programs for which quantity data are available is 29. The median of the average unit production costs for the ship programs is over $530 million, and the highest of the average unit production costs is over $1.45 billion.

The second distinguishing feature of the ship acquisition programs is that development costs are a low proportion of total program costs. Across the twelve programs for which total cost data are available, the mean percentage of development costs to total costs is 3.3 percent, and the median is an

even lower 1.6 percent. There are two basic reasons for these low percentages. The first is that much of what the rest of the defense industry refers to as development costs is included in Navy production costs; in particular, the costs of detailed design are typically funded by Ship Construction Navy appropriations rather than Navy development appropriations. The second reason is that the production costs for the ship programs include the costs not only of the ship and its associated propulsion (except for certain nuclear powerplant costs) and auxiliary equipment, but also the costs of the combat systems with which the ship is equipped.

The third distinguishing feature of the ship acquisition programs is that they have been taking place at a time of great overcapacity in the U.S. shipbuilding industry. The numbers of merchant ships over 1,000 gross tons produced annually by U.S. shipyards for both domestic and foreign ship owners have declined since 1949, because of cheaper operating costs for foreign flag shipping, and a recurrent boom and bust cycle of overcapacity in available merchant shipping tonnage world-wide. There are few alternative products for U.S. shipyards to produce, other than off-shore oil platforms, and structural and equipment assemblies for building construction and industrial use. As a result, there has been short-run pressure on shipyards to compete with lower prices. In the longer run, shipyards will go out of business, either voluntarily or involuntarily as in the cases of Lockheed Shipbuilding and Construction, Pennsylvania Shipbuilding, and Todd Shipyards, among others. Less overcapacity, and a smaller number of competitors in the future may result in higher production costs for naval ships.

The fourth distinguishing feature of the ship acquisition programs is the high cost of adapting equipment to operate in the stringent marine operating environment. The two primary environmental problems are corrosion from saltwater and humid sea air, and the pounding and shocks to the hull of the ship as it moves through the seas. As a result, non-maritime combat equipment is rarely adapted to maritime use (though the RIM-7H Sea Sparrow surface-to-air missile and the BGM-109 Tomahawk cruise missile can be used at sea and ashore). Further, the costs of combat equipment developed for the maritime environment inhibits its use elsewhere. As a result, there is an incentive to use expensive combat systems developed for a maritime environment across as many Navy programs as possible. This economizes on both development and production costs.

2. Outcomes of Ship Acquisition Programs

Acquisition program outcomes for the fifteen ship programs are shown in Table 7. Unlike the other acquisition programs in the study, development quantity growth is not included among the acquisition measures for the ship programs, because development quantity was typically not specified for the ships. (When it was specified, there was no change from the specified quantity.)

Table 7. Outcome Measures for Ship Programs (Percent)

Program	Development Schedule Growth	Development Cost Growth	Production Cost Growth	Stretch	Total Program Cost Growth
AEGIS	-4	28	N/A	N/A	N/A
AN/BSY-1	No	41	N/A	N/A	N/A
AN/BSY-2	N/A	N/A	N/A	N/A	N/A
SURTASS/T-AGOS	38	78	63	3	69
CG-47	-8	23	-6	-33	-6
DD-963	40	6	23	72	23
DDG-51	20	40	-6	-50	-1
FFG-7	15	40	59	80	59
LHA-1	56	0	58	225	57
LHD-1	6	9	-6	-22	-6
LSD-41	4	9	-8	50	-8
LSD-41CV	N/A	N/A	N/A	N/A	N/A
SSN-21	4	35	N/A	N/A	N/A
SSN-688	66	-8	-1	-74	-1
TAO-187	5	-3	-8	-3	-8

Note: N/A means that data were either not available or insufficient.

The only ship acquisition program outcome measure that has a significant relationship to its FSD year is development schedule growth. Development schedule growth is generally higher for the earlier programs and lower for the later programs, and this relationship is statistically significant at the 2.5-percent level. This would suggest that recent acquisition policies have been effective at producing ships on schedule.

For the ship acquisition programs, development schedule growth is not related to either development cost growth or production cost growth. On average, production cost growth is higher for programs with higher development schedule growth, but the relationship is not statistically significant

However, total program cost growth is higher, on average, for programs with higher development cost growth, and that relationship is statistically significant at the 10-percent level. Problems which increase the proportionately small development costs (small in relation to total costs) are likely to carry over into the detailed design efforts that are funded out of production costs. Production cost growth was generally less for programs that were modifications of previous ship programs, and this relationship was statistically significant at the 4-percent level. The same result had been observed for other types of programs.

3. Effects of Acquisition Initiatives on Ship Program Outcome Measures

The major initiatives applied to the ship programs are shown in Table 8. We examined Pearson correlation coefficients of the 1/0 variables representing the acquisition initiatives with the outcome measures. There were four significant correlations:

Table 8. Acquisition Initiatives Applied in Ship and Related Navy Programs

Program	Prototype	Dual-Sourcing FSD	Dual-Sourcing Production	Total package Procurement	Multi-year Procurement
AEGIS	Yes	Yes	No	No	No
AN/BSY-1	Yes	No	No	No	No
AN/BSY-2	Yes	Yes	No	No	No
SURTASS/T-AGOS	Yes	Yes	Yes	Yes	Yes
CG-47	Yes	No	Yes	No	No
DD-963	Yes	No	No	Yes	No
DDG-51	No	No	Yes	No	No
FFG-7	Yes	Yes	Yes	No	No
LHA-1	No	No	No	Yes	No
LHD-1	No	No	Yes	No	No
LSD-41	No	Yes	Yes	No	No
LSD-41CV	No	No	Yes	No	Yes
SSN-21	Yes	No	Yes	No	No
SSN-688	No	No	Yes	No	Yes
TAO-187	No	No	Yes	No	No

Program	Design-to-Cost	Fixed-Price Dev.	Contract Incentives FSD	Contract Incentives Production
AEGIS	No	No	Yes	Yes
AN/BSY-1	Yes	No	Yes	Yes
AN/BSY-2	Yes	No	Yes	Yes
SURTASS/T-AGOS	Yes	No	No	Yes
CG-47	No	No	Yes	Yes
DD-963	No	No	Yes	Yes
DDG-51	Yes	No	N/A	Yes

FFG-7	Yes	No	Yes	Yes
LHA-1	N/A	No	Yes	Yes
LHD-1	Yes	No	Yes	Yes
LSD-41	Yes	No	Yes	Yes
LSD-41CV	Yes	No	No	Yes
SSN-21	No	No	No	Yes
SSN-688	N/A	No	N/A	Yes
TAO-187	Yes	Yes	Yes	Yes

- Total package procurement is related to higher production cost growth and total program cost growth (.03). Total package procurement was also related to higher development schedule growth (.02).

- Prototyping is related to higher deve'opment cost growth (.03), contrary to expectations. Perhaps prototyping is more difficult in ship programs. In some sense, the lead ship serves as a prototype—production of the lead ship is where problem-solving takes place. Programs made extensive use of prototyping at the subsystem level. However, it may be that we are not seeing benefits because non-prototyped programs used an even more cost-effective strategy—using common, already-developed subsystems. For example, the AN/SPS-49 air search radar was used by five of the ships we examined--CG-47, DD-963, FFG-7, LHD-1, and LSD-41. The AN/SQQ-89 towed array sonar was used by four ships--CG-47, DD-963, DDG-51, and FFG-7.

- Incentive contracts in FSD are related to lower development cost growth (.02).

It is surprising that we do not see a statistically significant effect of dual-sourcing, a major Navy initiative, particularly in the 1980s. During that time, dual-sourcing was virtually universal for the programs in this group. We have only two programs with production data that were *not* dual-sourced—the LHA and the DD-963. Their production cost growth is higher than the dual-sourced programs.

IV. CONCLUSION

Ground combat programs include military vehicles and a set of distinctive Army programs. On average, the total program cost growth for ground combat programs is substantially higher than for other equipment types, while development cost growth and development schedule growth are among the highest. The averages mask considerable variability, however, and study of individual programs is necessary for a clear understanding. The Roland, which was canceled, has the highest total program cost growth, 319 percent. The MLRS program actually displayed negative cost growth. The Bradley Fighting Vehicle System has the highest development cost growth, 216 percent Development schedule growth for ground combat programs is high, 50 percent on average.

The outcome measures for ground combat programs are very different from the outcome measures for other types of acquisition programs. On average, the total program cost growth and production cost growth for the ground combat programs are substantially higher than other types, while development cost growth is similar to the tactical munitions. For comparison, acquisition program outcome means of ground combat programs and other equipment programs are shown in Table 9.

Table 9. Comparison of Ground Combat and Ship Outcomes with Other Types of Equipment

Equipment Type	N Programs (Dev.)	N Programs (Prod.)	Ave. Months in Dev.	Ave. Months in Prod.	Development Schedule Growth (ave.)	Development Cost Growth (ave.)	Total Program Cost Growth (ave.)
Ships and Related	14	10	90	166	17%	23%	18%
Ground Combat	9	9	82	97	50	52	136
Aircraft	27	25	72	135	14	33	27
Tactical Munitions	30	26	82	119	50	56	68
Other	19	14	92	119	41	55	42

Note: Total program cost growth could be calculated for only seven of the nine ground combat programs.

We examined whether management initiatives result in more favorable outcomes for ground combat programs. We found that, when we exclude the two programs that did not have any substantial production, there are few statistically significant correlations between the initiatives and the outcome measures. There are, however, some interesting relationships. For example, production cost growth averaged 8 percent for the MLRS and the M198 howitzer, which had multi-year contracts, while average PCG was 139 percent for programs without multi-year contracts.

The use of accelerated acquisition strategies in ground combat programs frequently led to unfavorable cost and schedule outcomes. In addition, these practices contributed to performance problems. In several cases, the system had to be abandoned or modified. Other factors that may have contributed to problems in ground combat programs are lack of industry capacity and lack of subsystem commonality.

The Navy ships and related acquisition programs comprise three combat data systems, ten classes of surface vessels, and two classes of attack submarines. Total program cost growth (18 percent, on average) is considerably less for ships and related programs, when compared with the other equipment types. The average of 23 percent development cost growth is also less than for other equipment types. Development schedule growth averages only 17 percent—apparently, ship programs had a good record in reaching initial operational capability when planned.

The major initiatives had some significant impact on program outcomes. Total package procurement is related to higher production cost growth and total program cost growth. Prototyping is related to higher development cost growth, contrary to expectations. Incentive contracts in FSD are related to lower development cost growth.

It is surprising that we do not see a statistically significant effect of dual-sourcing, a major Navy initiative. However, we have only two programs with production data that were not dual-sourced, and that may be a factor in the overall low cost growth for ships.

These outcome measures appear to be quite different from the outcome measures for the other acquisition programs in the study, as shown in Table 9. Total cost growth and production cost growth are much less for the ship programs, while development cost growth is somewhat less for the ship programs. Development schedule growth is much less for the ship programs, but production schedule growth is somewhat less.

Several features distinguish the ship acquisition programs from the other acquisition programs. The first is that there are generally low numbers of units produced with very high unit costs. The greatest quantity to be produced in any of the ship programs is 65.

The second feature is that development costs are a low proportion of total program costs. On average, development costs represent less than 5 percent of total cost. Much of what the rest of the defense industry refers to as development costs are included in Navy production costs, and production costs also include the costs of the combat systems with which the ship is equipped.

The third feature is that ship programs have been pursued at a time of great overcapacity in the U.S. shipbuilding industry. As a result, there has been great pressure on shipyards to compete with lower prices.

The final distinguishing feature is the high cost of adapting equipment to operate in the marine environment. Protecting ships against corrosion from saltwater and sea air, and the pounding and shocks to the hull of a ship from normal operations, is very costly. The high cost of adapting to the marine environment encourages subsystem commonality, which may be a significant factor in the low cost growth for ship programs.

ACQUISITION MANAGEMENT OF CONSUMABLE TECHNOLOGY UTILIZING A NOVEL TECHNOLOGY TRANSITION PROCESS

Russell E. Urzi , USAF

ABSTRACT

The traditional approach towards acquisition of military hardware is inherently slow. By the time the weapon system is being delivered many of it's subsystems no longer meet the real needs of operational missions. Also, missions themselves evolve and yesterdays subsystem may no longer be adequate. Hence, the system is forced into expensive retrofit in order to get it up to the desired capability. A classic example of this occurs with the aircrew transparency subsystem. Typically, the aircrew transparency subsystem is of secondary concern in the aircraft design process and in the evolution of aircraft mission assignments during the life of the aircraft. This can result in an urgency driven, very expensive, redesign, and in this current tight fiscal environment, this process will clearly not do anymore.

A proven process for accelerated transition of technologies can be used to overcome these problems. This process to rapidly transition laboratory R&D to operational use evolved using principals which are now more commonly referred to as a TQM approach. This process can be used on any subsystem which is consumable, that is, it wears out and requires periodic replacement.

This paper explains this process, describes several examples of its application, and suggests applications in which it can be used in a broader sense.

INTRODUCTION

A common criticism is that the results of Laboratory Research and Development efforts are too slowly exploited into better/cheaper operational hardware. Rapid advancements are being made in the areas of cost reduction technology and to achieve technological superiority. These technology advancements are keeping pace with the ever changing missions demanded of the military.

Because some of these technology advancements have only recently been available and the rate at which the laboratory is progressing is much faster than before, some subsystems, while acceptable, may not be optimal. For their time, these subsystems were the best they could be, but now they could benefit from further technological advances. It is these subsystems that could benefit from the proposed process to rapidly transition the Research and Development advancements to operational usage.

To illustrate, take for example the evolution from high altitude bombing to low altitude precision strikes. Among the various aircraft subsystems which must also evolve concurrently is the aircraft transparency. At lower altitudes, there is an increased risk of birdstrikes, as well as erosion from particulate matter suspended in air. The transparency system must be able to cope with this new environment. The transparency system of an existing fighter aircraft is a good example of this mission evolution and its resulting consequences.

An early transparency system (canopy) was constructed from a single sheet of material and had a birdstrike resistance of less than 200 knots. It soon became apparent that at lower altitudes (below 3000 ft) an increase in birdstrike resistance was needed. A canopy was developed and provided protection to 350 knots. However more problems developed because of this low level environment, chiefly, abrasion of the canopy resulting in a loss of optical clarity. (Operation Desert Storm was a good example of this phenomenon being experienced on many aircraft.) Aircraft were also performing this mission at speeds higher than 350 knots, and with onboard equipment necessitating improved optical quality of the canopy. Consequently, the canopy had to provide even more birdstrike protection as well as abrasion resistance and improved optics. This requirement evolution took place over a 15 year period during which more complicated canopies were developed to meet these requirements as well as extending the service life of these parts. This was all accomplished by using the following technology transition process.

THE PROCESS - "PRELUDE"

The process can be explained much like the tires on your car. They wear out and need to be replaced. Your type of car and to some degree your personality, will determine what type of tires you will purchase. All must be durable and low cost. The sports car driver will insist upon good traction and manuerverablity for negotiating curves, the off-road four wheel drive vehicle will opt for more rugged construction and better traction, and finally the land yacht owner will opt for quiet and comfort. Each will evaluate the performance and durability of their current tire against these standards in selecting a new tire.

The tire manufacturers are constantly striving to provide better products in order to obtain more of the market share and consequently more profit. Hence, the consumer (driver) is faced with many more possibilities than say a year or two ago. He may consult with a auto mechanic or test agency before making any purchase decisions. Once these evaluations are completed, the consumer will make his choice of tires. He will drive these tires, form his own impressions about their performance and durability, and eventually wear them out. The process then starts all over again.

This oversimplified explanation illustrates the key concepts involved. One fundamental concept is that some weapon subsystems are of a consumable nature and eventually wear out. And, that when they do wear out, the replacement should meet the requirements necessary to fulfill the mission.

The operational users, together with the system developers, maintainers, industry, testing and supporting laboratories form the basis in which this process works (i.e. the stakeholders.)

The second fundamental concept is that the stakeholders who have ownership of the weapon system want to deliver the best product they can possibly achieve. This is absolutely necessary for success! For without this personal commitment, the weapon system is doomed to mediocrity.

When these two fundamental concepts or conditions are met or exist, then the process may proceed as explained in the next section.

THE PROCESS - "FUGUE"

The first step in the process is to identify what performance and/or supportability features of the subsystem should be improved. The subsystem must be of a consumable nature and would be replaced periodically. Usually a standard criterion is used in order to make the determination of whether the current system is good enough or should be improved. However, this standard is of a dynamic nature and changes with the situation. To continue the transparency example, the Air Force uses the "444" concept as the standard to which transparency systems are compared. Simply stated, a transparency system should perform its mission for a minimum of four years after which it should be able to be replaced by no more than four technicians in four hours. Embedded in this standard are both performance and supportability features.

Once the standard is identified, a decision must be made. That is, should the subsystem be upgraded, procured as is, or both? Usually, the subsystem being of a consumable nature can be upgraded, but the upgrade must be proven sufficient to warrant the risk of purchase.

This decision is best done by the stakeholders. The using commands will comment on the performance, the maintainers on the supportability, etc. If the current subsystem is not okay, then the stakeholders must proceed to the next step.

The next step relies upon the supporting laboratory to apply emerging technology to the subsystem. The laboratory is constantly developing, integrating, validating and transitioning technology to meet mission performance requirements at lower cost. Depending upon the maturity of the technology, the subsystem may benefit immediately. It is important to note that of the stakeholders, the laboratory is best suited for this task, and not say the system developer. The reason for this is that quite simply the laboratory is where technology risks are taken at minimal cost. Taking new technology and inserting it into the Engineering, Manufacturing and Development phase is much riskier and more costly.

When the new technology is applied to the subsystem, a prototype must be evaluated. This evaluation could be in the form of a "critical experiment" or an "operational evaluation". What is important in this step is that the evaluation must include all the stakeholders. If for example the operational command was not present, then there could not be any feedback on it's suitability for field use. Likewise, a similar logic could be said of the logistics command. The basic point is that the evaluation must not occur "in a vacuum".

If the operational evaluation was a success, then the technologies embodied in the subsystem could immediately be procured in an upcoming spares buy. Again, if the stakeholders were properly working together from the beginning this would not pose a logistics problem. If the subsystem did not perform as desired, then back to the laboratory it goes for continued technology development. This ends up being a somewhat cyclic process paced to coincide with specific upcoming spares buys.

As a case example, let's examine the transparency subsystem for an existing bomber. The current production design windshield had a service life of less than one year (350 flight hours) due to delamination of the outer glass ply, forcing the Air Force to spend $10 million per year for spares.

Addressing this service life issue was truly a joint effort between all the stakeholders. The stakeholders working together agreed to a service life interim goal of two years. Doubling the service life to two years was definitely not consistent with the first "4" (4 year service life) in the "444" concept. But, the stakeholders agreed that the technologies to support an interim goal of two years could be demonstrated, with reasonable risks, in time to coincide with an upcoming spares buy. And, that the savings from this procurement against the interim goal would be a welcome reduction to Air Force costs of ownership while the four year service life goal was pursued.

Technology transition to users was realized as the prototype windshield designs went into production. This stakeholder technology exploitation team was working so well that in less than one year the stakeholders again selected a prototype windshield design to replace the current production windshield.

The new windshield designs provide 100% increased service life at half the cost of the initial production design. The Air Force is expected to save \$7.5M per year for spare parts as a result of this technology transition. This savings is coming from increased service life and a result of competition between the vendors. The unit cost of the windshield dropped from \$62K to \$25-\$33K since the program started.

The key reason for this success, is the close relationship that has been developed and maintained between all the stakeholders. The users, the logistics community, the laboratory and industry were full team members from the earliest phase, and their **active** participation throughout the program ensured a smooth and rapid transitioning of technology as soon as it was successfully demonstrated. The team is continuing in its quest to transition emerging technologies to meet the "444" goal.

THE PROCESS - "VARIATIONS"

We have encountered many applications where this process could be used to focus technology development and then rapidly transition it to operational use. One area which is just beginning to use this process is aircraft engines. The Propulsion System Program Office at Wright-Patterson uses a similar process to replace engines in high performance aircraft. The only criteria for successful application is that the two fundamental concepts discussed earlier be in place. Other examples include tires, brakes, wheels, and ejection seats. This process is not just confined to subsystems associated with aircraft but could be applied to any weapon system or platform.

SUMMARY

This paper has explained a technology transition process to rapidly transition technology from the laboratory to operational use. The only criterion needed is that the subsystem be of a consumable nature and the two fundamental concepts be in place. Additionally, this process requires a "team approach" to accomplish the transition. This is probably the most critical element in the process, because if this teaming did not occur then technology transition would be just "over the wall". This team is actually the stakeholders in the weapon system. They have a personal commitment to producing/maintaining the best system for the operational commands. Together, a close working relationship among the stakeholders is the key to successful technology transition.

ENDNOTES

1. Draft Proposed Aeronautical Systems Center (ASC) Technical Planning Integrated Product Team Charter dated 4 Dec 92. This charter brings together the vital stakeholders in the systems acquisition process in a forum to meet projected operational user needs.

SUPPORTING A WAR: AN ANALYSIS OF CONTRACTING SUPPORT DURING OPERATIONS DESERT SHIELD/STORM

by

Dr. Rita L. Wells, CPCM
Industrial College of the Armed Forces

ABSTRACT

During Operation Desert Shield/Desert Storm, Department of Defense (DOD) contracting organizations within the continental United States were called upon to react quickly to defense weapon and logistical wartime needs. This quick reaction required extraordinary measures. Contracting professionals for all the military services and the defense agencies were required to research the regulations and public laws to determine what was permitted under such circumstances, coordinate with other levels in their organizations and work closely with the industrial base. Following Desert Storm, much effort was spent definitizing and documenting wartime contracting efforts. This study was conducted in order to determine the methods used by the military services and Department of Defense (DOD) agencies to contractually procure equipment, supplies, and services during times in which procurement by normal contracting channels would endanger national strategies. The study centered on the expeditious transactions that those agencies located within the continental United States (CONUS) used in order to shorten overall procurement times for the equipment and supplies required by Operation Desert Shield and Operation Desert Storm (ODS).

INTRODUCTION

Operation Desert Shield refers to the period from August 7, 1990, when President Bush ordered U.S. forces to Saudi Arabia, to January 17 1991, when the coalition air campaign commenced. Operation Desert Storm refers to the period from January 17, 1991 to February 27, 1991 when the cease fire was declared. It is important to note that during Operation Desert Shield, the U.S. had approximately four months to procure necessary supplies before the air or land campaigns began.

This particular type of contracting, best represented by the phrase "CONUS contracting," differs from contingency contracting only in the fact that the needed suppiies are purchased in CONUS rather than in the theater of operations.

On February 21, 1991, Secretary of Defense Dick Cheney revealed a new military strategy in an address to the Senate Armed Services Committee. The following quotation, taken directly from that speech, best describes the new strategy:

"The most important change reflected in this new strategy is that we no longer are focused on the threat of a Soviet-led, European wide conflict leading to global war...The new strategy shifts its focus to regional threats and the related requirements for forward presence and crisis response...The regional contingencies we might face are many and varied...One trait

most of them share, however, is that they will arise on very short notice and therefore require a highly responsive military capability." (1)

This new strategy requires the United States DOD to be capable of the rapid deployment and support of troops anywhere in the world. In order to implement this strategy the various contracting organizations of DOD must possess the ability to award contracts quickly to support operations in the theaters of conflict.

Operations Desert Shield and Desert Storm are examples of the types of conflict the military may experience in the future. All of the agencies within the DOD prepared for ODS in their own ways. The preparations for the conflict required that the contracting professionals research regulations and public laws, coordinate with other military organizations, and work closely with the defense industrial base in order to meet the logistical needs of the troops deployed in the theater of conflict as rapidly as possible. Consolidation of the various methods used within the DOD to contractually support ODS has the potential to aid in educating contracting professionals to effectively and efficiently support a future military contingency. Another important aspect of this study is to reveal any particular regulations and laws that need to be changed in order to expedite the support of military contingencies.

The objective of this research was to compile success stories, lessons learned, and develop a quick reaction contracting model. If similar conflicts occur in the future, defense contractors and contracting organizations will be called upon again to quickly react again to weapon and logistical wartime needs. That is why it is so critical to capture and document the lessons the contracting community learned during Operation Desert Shield/Desert Storm.

METHODOLOGY

A qualitative research study was conducted during the period from December 1991 to September 1992. Focus group meetings were conducted at organizations which were heavily involved in providing contracting support during ODS. (2) Personal interviews were also conducted with individuals who responded to press releases about the research and requests for information published in journals. During these focus group meetings and interviews, open ended questions were asked concerning experiences in providing contracting support during ODS.

Critical factors which affected contracting support of ODS were identified through these discussions. The researchers then used these critical factors to structure a Delphi questionnaire.(3) Following a pre-test for content validity and clarity, the questionnaire was sent to a select group of experts. Initial responses were compiled and returned to the same group of experts for further comment. Anonymity of respondents was maintained during the entire process.

The result was a rich body of information about the experiences, lessons learned, and recommendations of people at the grass roots level who were personally involved in providing support. The respondents represented all the military services and key defense agencies. There was representation from people at both the working level and senior management. In order to assess the possibility of meaningful differences among the diverse respondents and in an attempt to add additional rigor to this qualitative study, a matrix was developed to analyze the data.

The data was examined to ascertain whether meaningful differences existed both intra and inter organizationally. Although most of the respondents were involved in contracting positions, there also was representation from program management, transportation, and production specialists.

FINDINGS

An eighty percent response rate to the Delphi questionnaires was experienced.(4) The information provided by the respondents to the study was generally uniform across the services and DOD agencies. No major differences were perceived in any of the answers due to agency affiliation.

Differences Among Groups. The only difference in responses among groups was attributable to differences in organization levels. Respondents in senior leadership positions perceived their headquarters personnel as demonstrating a distinct sense of urgency during ODS. Respondents at lower levels in the organizations held the opposite perception. In fact, field level personnel cited several specific instances in which they felt that headquarters personnel were impediments to getting needed products to users - either through inaction or through *additional* requirements imposed on the normal processes.

Below is a summary of the responses:

ODS Supplies and Services. The respondents were involved in the acquisition of a wide variety of supplies and services for ODS. Among the items they procured were: spare parts, equipment, weapons, ammunition, communications, transport services, food, clothing, aircraft modifications, diagnosis and repair.

Where Used. The items procured by the respondents were used in many different areas. Some were procured for use in the area of operations. Others were to remain in the U.S. as replacements for items already shipped to the theater of operations. Some were used for training, for repair depots, and as reserves worldwide.

Contracting Methods. The respondents used a variety of contracting methods. Where possible, they accelerated delivery on existing contracts. New contracts and purchase orders were awarded, options were exercised, orders were placed against Basic Ordering Agreements (BOA's) and requirements contracts, and equipment was leased. The "borrow-payback" method of taking delivery of spare parts from weapon system production lines was used. Only ten percent of the respondents used cost type contracts.

Competition was achieved for a large number of the procurements; however, it was not always "full and open" competition due to the urgency of the situation. Most of the procurements were negotiated; placing an enormous workload on the CONUS contracting organizations. Several respondents reported that contractors started work without contracts - at their own risk.

Source Development. Fifty percent of the respondents reported that it was necessary to develop new sources for the ODS procurements. Various methods were used for source development. Several commercially available items were used; often modification to meet military needs was necessary.

Accelerated Delivery. The majority of the respondents reported specific actions taken to accelerate delivery. Where possible, inspections were accelerated and packaging specifications were waived in favor of "best

commercial" practice. In some cases contract modifications were made to adjust the delivery schedules of items not accelerated as a trade-off. One respondent indicated that first article tests were waived in order to facilitate early delivery.

Approximately half of the respondents reported that there was an additional cost to accelerate delivery. In most cases the additional costs were for contractor overtime. One respondent replied that the contractor requested premium pay and the modification of delinquent contracts but that the government refused to pay for those increases in price. A few respondents reported that no extra charges were required to accelerate delivery.

Relationships With Industry. Most respondents reported very good relationships with industry during ODS. Many anecdotes were reported of contractors "going the extra mile" to provide assistance. Some contractor technicians deployed with their systems and lived in tents along with the military members using the systems. Detroit Diesel put aside their commercial work and delivered engines in two weeks. Employees of Donaldson Filters showed up early at the plant "not expecting overtime" to be sure there were enough filters for the war effort. A tire dealer in Texas rented a U-haul to get tires to the Army base that was transporting them. Many contractors went through "what-if" drills over and over, and made excellent suggestions on speeding up actions. One respondent stated that GE's aircraft engine division worked directly with government personnel in assessing needs for parts by engine model, manufacturing capacities, and the abilities of vendors to provide raw materials and components.

Respondents reported that contractors began preparing and planning when requirements became known, even without contracts in place. One respondent reported that contractor CEO's were available for discussion of any issue. Contractor employees at all levels did not have to be asked to perform; they only needed explanations of what was required. Contracts were negotiated on the weekend and contractors had people working around the clock. Some contractors paid for transportation upgrades at their own expense. Shipowners generally were very responsive to the government's transportation requirements, but because they were high in demand they could negotiate at the high end of the price scale. Only one respondent reported that some contractors tried to take advantage of the situation.

There was unanimous agreement among the respondents that there was a difference in industry support during ODS as compared to before or after ODS. There was an air of cooperation that did not exist before ODS. Some contractors were willing to work without formal contracts and frequently at no change in contract price. "Total team effort" was one respondent's description of the difference in industry support during ODS. In one case eleven contractors worked together as a team to make one ship ready.

Patriotism was repeatedly given as the reason for the change in industry support during ODS. Some other reasons were the desire for the company and equipment to "look good," and pride in wanting to support the systems. Only one respondent attributed the change in the relationship with industry to increased business opportunities.

Waivers To the Regulations. Many suggestions for waivers that would have been helpful during ODS were given. An

increase to the Justification and Approval (J&A) review threshold for contracts awarded through other than full and open competition would have been helpful during ODS. Respondents suggested waiving the small business review during ODS. Other waivers that would have been helpful to the respondents were concerned with undefinitized contractual actions (UCA's). Respondents reported that the delegation of approval for UCA's over $5 million to lower levels would have helped speed up procurements during ODS. Deviations to the law restricting amount of expenditures which can be made under a UCA would also have been helpful. Some other suggestions for waivers that individual respondents reported would have been helpful during ODS were as follows: waiver to the Service Contract Act concerning wage determinations, waiver of the synopsis publication and response time, and waiver to the necessity for cost and pricing data.

Several suggestions were made concerning actions the individual military departments could have made during ODS to make awarding of contracts faster. These are as follows: the designation of urgent ODS requirements as Public Exigency requirements, the execution of a *class* "unusual and compelling urgency" Justification and Approval (J&A) for certified ODS requirements, the waiver of all reviews except contracting officer and Judge Advocate General (JAG) for any contract document implementing urgent ODS requirements, the waiver of acquisition plan format, the approval to automatically continue performance of an ODS contract in the face of a protest at the Government Accounting Office (GAO) level, and the delegation of Head of Contracting Agency (HCA) individual FAR deviation authority to the product division for urgent ODS contracts.

One respondent relayed an incident concerning waivers that occurred in the early 1980's that was pertinent to ODS. A buyer in the respondent's organization sent a suggestion to higher headquarters requesting waivers and changing the delegation of authority to lower levels for military contingency operations. The headquarters' response at that time was that the suggestion did not need to be processed because waivers would be granted when necessary. However, that organization's request for a class J&A during the early stages of ODS was not processed. The headquarters insisted that each contractual action have its own J&A. This respondent also reported that later during ODS the headquarters issued a request for information on suggested waivers, changes, or regulatory relief, to include documented support for each suggestion. A very short suspense was given to the field. The respondent reported being incensed at that request because of the headquarters' lack of response to the class J&A request they had made months earlier.

Several of the respondents reported requesting a waiver or deviation. Of those requesting waivers or deviations, only two reported that their requests were granted. The reasons given for not requesting a waiver or deviation generally dealt with the necessity for speedy award of the applicable contracts. One respondent reported that the organization did not request a waiver because they were told that the request would not be approved. Several respondents reported that because of the urgency of the situation there was not enough time to process a waiver request. Another respondent reported that because the expenditure limit for UCA's is a legal limit, a change would require a change in the law, which would also have taken too long.

Justifications and Approvals. The dollar threshold for local approval of Justifications and Approvals (J&A's) during ODS varied among the organizations surveyed. Eight respondents reported that their threshold for local approval was $10 million. Some other thresholds reported were $25 million, $1 million, and $50 million.

Approximately one third of the respondents reported that the majority of their procurements which required J&A's fell under their dollar threshold.

Six respondents requested blanket J&A's for ODS. Only three respondents received approval to use a blanket J&A for ODS. One of these reported that the approval was only for certain classes of items.

Those respondents not receiving approval for a blanket J&A reported various reasons. One respondent reported that their activity's headquarters refused to forward the request to the military department. Another respondent stated that the organization was advised by their approval authority to "satisfy the requirements of the Competition in Contracting Act (CICA)." [It is interesting to note that the use of a blanket J&A under situations such as ODS does satisfy the requirements of CICA.]

Inspections. Half of the respondents' organizations have been inspected after ODS. None of the respondents reported any adverse findings related to ODS procurement actions. One respondent replied that one inspection finding was that because the contracting staff was not augmented to contend with the increased work load during ODS the documentation processing was delayed or incomplete.

Requirements. The respondents reported that the requirements for ODS were originated much the same as they are in peacetime: from using commands through the program office to the contracting division. The requirements for food were generated within the contracting organization, based upon the classified troop strength.

Four respondents stated that they received requirements on a daily basis. Respondents reported requirements arriving even before Desert Shield began and continuing throughout the conflict as requisitions came in, as stock levels were inventoried, as studies were completed and demands anticipated.

In half the cases requirements were clearly described. One respondent replied that the request was for something to be done to make certain weapons better, not for a specific weapon. Another respondent stated that the requested delivery dates changed frequently causing changes to requests for proposals (RFP's). These changes caused problems because during ODS the normal award time from issuance of RFP to award was three days for that organization. One respondent reported that the user requests the organization received were not for specific items, but were of the "what if" variety. Another respondent stated that the initial requirements were clear, but that they kept changing throughout the conflict.

Although half the respondents replied that funding was available when the requirements were first identified, lack of money was a problem for the others. Respondents reported that frequently no funding was available with the requirements. One of these reported using the contracting organization's funding in some cases.

If requirements were not clearly identified or if funding was not available in a timely

fashion, the respondents performed a variety of different actions to assist in the contract award process. Two respondents reported that they acted as if funds were available and found that in most cases the funds arrived before they were ready to award the contracts. One respondent replied that the "contracting [organization] was not going to be the reason a contract award was late." Others stated that some efforts were delayed due to the wait for funding.

Approximately one third of the respondents reported that their relations with the ultimate user did not change as a result of the experiences with ODS. Others indicated that a better relationship and greater understanding of the user's needs now exists. Another respondent stated that better communications links were established with the users during ODS and have been maintained to date. One respondent replied that the user still wants requirements met as quickly as they were during ODS.

Communications. During ODS eight organizations did not have direct communications link-ups with individuals in the area of operations. The respondents who did communicate with individuals in the area of operations during ODS used various methods: telephones, facsimiles, official messages, electronic mail, ship-to-shore communication, and letters.

Approximately half of the respondents reported having a dedicated point of contact in the area of operation. One of these was a person assigned there specifically for the purpose of communicating with the office in CONUS. The dedicated points of contact were of the following specialties: contracting specialists, end item users, distribution, logistics specialists, and engineering.

The frequency of communication with the contacts varied from once a week to more than once a day.

The communication with the contacts in the area of operations covered many different subjects - what was needed; when items were needed; when items would be delivered; the redelivery of some items; the marking, containerization, or transport of the needed items. Some other subjects that were discussed were leased vehicles return dates and conditions, problems encountered with repairing vessels, contract administrative items, requirements definition, backorders, and if contractors were working on other ODS orders.

Some respondents reported discussing whether items would be bought in the CONUS or in the gulf area with their points of contact. The primary factors influencing the decision to make purchases in the area of operation or CONUS were quality, timeliness, cost effectiveness, and the conformance of the supplies.

Delivery Follow-up. Half the respondents tracked the delivery of the procured items to the area of operations and reported a variety of experiences. One respondent reported a high success rate because much of the material was hand carried by a contractor or met at both ends by a contractor or military person. Another reported that everything was tracked from the vendor to the port of departure but that trace was lost at the tranship points in Spain. This respondent also noted that because there was no stock control system in theater some receivers did not know whether or not they received some items. Another respondent reported that transportation was a big problem because of the difficulty in getting material into the port at New Cumberland. Contractors had difficulty finding truckers to pick up their material because the truckers did not want

their rigs tied up while they waited to get into the port. Workers in the contractor's plant who had worked extremely hard to quickly manufacture parts became frustrated when they saw the material sitting on the dock awaiting transportation.

One respondent hired a field service representative from a contractor, Mack Truck, and another who was familiar with commercial vehicles. The representative were at the port when the ships docked in the theater of operation so that the equipment could be successfully mated for use. One respondent reported that vessels were tracked using all types of communication from the time of delivery to the load port, ocean transit arrival in discharge port, until redelivery of vessel to the ship owner.

Contract Payment. Over one third of the respondents stated that their contractors encountered payment problems with ODS contracts. Several different reasons were given for the problems. One respondent attributed the problems to the lack of familiarity of commercial contractors new to dealing with DOD. The UCA expenditure limit caused some payment problems because contracts were awarded and parts shipped before the action could be definitized. One respondent replied that part of the problems was due to the reorganization of the payment office at that organization. Other reasons that were given were that the payment office was overwhelmed with work, and a perception that some of the people in the payment offices did not care.

Workload Impact. Only one respondent answered that the workloads of the individuals in that organization did not differ from the normal, non-ODS workload. More overtime was required during ODS than for the normal workload for all except two respondents. Over one third of the respondents reported that overtime was used extensively. They reported using overtime constantly. Another twenty percent used overtime frequently.

Half the respondents reported no use of extra employees. The others reported using reservists, temporary employees, and borrowed employees from other organizations. Retired civil service annuitants were used during ODS in the organizations of three of the respondents. Employees in seventy-five percent of the respondents' organizations worked week-ends during ODS. Many reported people working on holidays to support ODS procurement activities.

Seventy-five percent of the respondents' organizations had personnel on-call via beeper or restricted travel during off-duty hours during ODS. Four respondents were on-call constantly.

Several additional comments were made concerning the workload during ODS. One respondent answered that routine buys were postponed and individuals were not able to do as much planning and follow-up as usual. ODS forced people to move into more of a reactive instead of a proactive mode.
A respondent replied that payment for overtime was never discussed. One respondent reported that productivity increased 50% per hour per person and that almost no sick leave was taken during ODS. Another respondent suggested that even though the DOD is downsizing we should attempt to retain trained, knowledgeable individuals who would be available for use in an emergency by using part-time, or job sharing programs in government offices. This respondent explained that because it takes three to five years to train buyers,

hiring new employees in an emergency would not be as effective as converting a trained, part-time employee to full-time would be.

Sense of Urgency. Individuals in the contracting offices of most of the respondents demonstrated a distinct sense of urgency in accomplishing the ODS support mission. Respondents reported that buyers and contracting officers, local review committee members, legal staff, and price analysts showed a sense of urgency during ODS.

Higher headquarters personnel were reported to demonstrate a sense of urgency less often than the contracting office personnel. The most common complaint was that both local and headquarters staff offices treated the ODS requirements as normal business. One respondent answered that "those [people] that were not responsive to my needs could be easily forced to be so by emphasizing their contribution or lack of same to the war."

One third of the respondents reported that contract administration office personnel (Defense Contract Management Command (DCMC) were responsive to the urgency of the ODS situation. However, one respondent reported a very frustrating episode in which a DCMAO transportation representative ordered a contractor not to ship needed items which consequently missed the boats that the Program Executive Officer (PEO) had scheduled specifically. The transportation contract had to be terminated and the contracting office personnel had to work all weekend to find other trucks that could still meet the boats' departure date. No reason was given for the representative's actions.

Two thirds of the respondents reported that the contractors they worked with during ODS demonstrated a sense of urgency.

On the positive side, a respondent reported that there was not "one example of someone who refused to help. Some only gave 10% over their usual amount, some gave much more." One respondent answered that "everyone bent over backwards to do their jobs" and then asked what else could be done. Other respondents commented that everyone involved in ODS procurements worked as a team and went "above and beyond the call."

Organization Structure. Two thirds of the respondents worked in functionally structured organizations before ODS. Only three respondents worked in matrixed organizations prior to ODS.

One third replied that their organizations formed special teams to support ODS. The teams that were formed were composed of individuals from many different backgrounds. The respondents reported that the makeup of the teams consisted of representatives from the following functional areas: comptroller, logistics, engineering, test wing, laboratories, quality, technical, supply, procurement, military service, production, contracting, transportation, maintenance, product assurance, readiness, administrative contracting officer (ACO), price analyst, supervising surveyor, and "trade people."

The operation of the teams differed from organization to organization. One respondent described the operation of the Air Force's Rapid Response Process (RRP) team. The RRP team was set up as a focal point for incoming combat mission needs statements (CMNS) from ODS users. The team was to analyze the need, direct the work to a specific program office, and to

present an alternate fix if necessary. The team worked toward a 48 hour turn around from identified need to a suggested fix and the strategy to accomplish the fix. The team also acted as consultants to the program offices if needed.

Several team operations attempted to solve problems dealing with transportation, delivery, forecasting amounts, acceptability of deviations from the specifications, modification of inspection criteria, and acceptability of substitutes.

Respondents reported that the team members were selected for their high level of expertise. Two respondents answered that the team members were chosen by a higher authority. These respondents did not give information on the basis of the choices. Others replied that team members were chosen who were compatible with others.

Only four respondents reported that the teams were continued after ODS. One of these answered that the team was continued as the result of the drawdown decisions. One negative response included the explanation that organizations "cannot keep all the best on one team."

Co-workers Experiences. The majority of respondents reported variations on the theme of the pride their co-workers felt for their support of ODS. Only one respondent reported negatively to this question, and that response dealt with the lack of urgency shown by individuals in the staff offices.

Challenges. Many challenges were faced during ODS by all of the respondents to this questionnaire. The most frequent challenge given by the respondents was performing all the aspects of the procurement process as rapidly, and accurately as possible. One third of the respondents reported that one of their greatest challenges was getting individuals in staff and other offices not directly supporting ODS to expedite ODS related work.

Another challenge was the lack of a pre-planned streamlined acquisition process designed specifically for supporting military contingencies. Respondents replied that the recent personnel cutbacks caused challenges in supporting ODS procurements. Getting funds in a timely manner was a challenge during ODS. One respondent replied that getting contractors to understand that the war did not mean that "anything goes" was a great challenge during ODS. Another indicated a similar problem with program offices who attempted to use ODS priority for non-ODS requirements. Another reported the challenge of balancing ODS priorities with the every day program priorities in order to insure that both were accomplished. One of the respondents was challenged with "getting the latest and best to the field without getting ahead of spares" and training requirements. Two respondents replied that overseas transportation was a significant challenge faced during ODS.

One respondent reported that the selection of the best contractor was a challenge during ODS due to the necessity for the decision makers to consider the best value in terms of delivery schedules, quality, as well as price. Others answered that finding new procurement sources was a challenge during ODS. Anticipating requirements was a challenge during ODS. Individuals in one organization were forced to move from their normal reactive mode to a more proactive mode in order to best serve the needs of the troops in the field.

Other respondents stated that dealing with organizations or subject areas that were rarely ever dealt with before (state level and

DOD transportation authorities, bankers, and payment offices) while still abiding by contract terms created a significant challenge during ODS. Completing all the required contract file documentation under the time constraint posed by ODS was a major challenge. Another respondent replied that obtaining the users' accurate need dates before deployment was a challenge in supporting ODS procurements. The development of "streamlined internal office procedures for managing fast-paced procurements with large numbers of offerors on each solicitation" was reported.

One respondent reported that getting contract technicians to the theater and obtaining clearances to deploy were significant challenges faced during ODS. Another respondent replied that assisting customers in writing Statements of Work (SOW) was challenging during ODS. Another stated that prioritizing multiple orders from different sources for one contractor's product created a significant challenge during ODS.

Challenges After ODS. The aftermath of ODS also created challenges for the respondents of this study. Half reported challenges dealing with modifying or terminating contracts after ODS ended. One of these respondents replied that modifying or canceling contracts without seeming to destroy the industrial base or punish the contractors proved to be especially challenging. Others reported challenges encountered when making monetary adjustments to ODS contract modifications or terminations. The adjustments mentioned were the war risk bonus, fuel adjustments, and cost estimates for work completed at the point of "stop work."

Other respondents reported that a major challenge they have encountered since ODS ended was preparing for the downsizing of DOD and being able to support future efforts with less people. Definitizing letter contracts was a challenge after ODS. One of those respondents also stated that explaining to the program office why we could not use UCA's and letter contracts on a day-to-day basis after ODS proved to be challenging.

One respondent reported that understanding that the organization's support of ODS did not end with the official end of the hostilities was a challenge. Another stated that identifying excess levels of supplies in theater created a challenge after ODS ended. One respondent reported that returning stock levels to that used before ODS was a challenge. Getting equipment returned to the CONUS proved to be challenging after ODS ended. The challenge of recognizing both contractors and employees "whose outstanding support was obvious" during ODS. One respondent replied that "capturing the streamlining ideas and permanently improving the procurement process" has been a great challenge since ODS ended.

Training. The majority reported that they did not receive any special training for responding rapidly to contracting needs for a military contingency. Twenty-five percent answered that their training was the years of experience they gained on the job. One respondent replied that all mandatory training requirements were received, but that none of the training was designed specifically to prepare for military contingencies. Another respondent received inter-office training on international airlift purchases.

One respondent stated that the training should have been more structured and given at the beginning of ODS.

CONCLUSIONS

Based upon the results of the research, the following recommendations are offered:

1. Capture the experiences and lessons learned from contracting support of ODS. It may not be the same as future conflicts, but there is much we can learn from this most recent experience.

2. Develop a "readiness contacting" package which identifies all the waivers which can automatically be put into place in the event of a conflict like ODS. Headquarters staff should take the initiative and be prepared to support contracting personnel who do the acquisitions. As defense resources are decreased, future workload will fall on even fewer shoulders. Action should be taken now to provide relief under any similar circumstances in the future.

3. "Wars start with spare parts." Identify the critical spare parts for weapon systems. Recognize that there may be different lists for different environments and conflicts. Avoid JIT inventory of critical spare parts.

4. Train contracting people on how to support a war. Include procurement in wargaming exercises. Contracting professionals need to be trained, primed, and ready to react quickly when needed.

5. Push down decision making authority and accountability where possible. We have a committed, highly trained, and increasingly professional contracting community. The authority for a class Justification and Approval should be granted for future conflicts.

6. Last, but most important of all, recognize and express appreciation for the committed industry and government contracting people who worked so hard and made many personal sacrifices during ODS. With their pride, spirit, and professionalism they have shown the contracting community a pathway to excellence.

ENDNOTES

(1) Cheney, Dick. "A New Defense Strategy for Changing Times," Defense 91 March-April 1991, p. 11.

(2) Dalkey, Norman C. Delphi. Santa Monica, CA: The Rand Corporation, Oct 67.

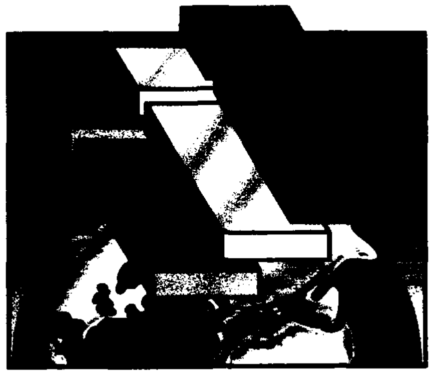
(3) Dillman, Donald A. Mail and Telephone Surveys. New York: John Wiley and Sons, 1978.

ACQUISITION

FOR THE

FUTURE

P R O G R A M



1993 ACQUISITION RESEARCH SYMPOSIUM

ACQUISITION FOR THE FUTURE: IMAGINATION, INNOVATION, AND IMPLEMENTATION

RESEARCH AND REALITY:
CLOSING THE GAP

CO-HOSTED BY THE
DEFENSE SYSTEMS MANAGEMENT COLLEGE
AND THE NATIONAL CONTRACT MANAGEMENT ASSOCIATION
WASHINGTON, DC CHAPTER

1993 ACQUISITION RESEARCH SYMPOSIUM

CONFERENCE OFFICIALS

Conference Co-Chairs

Calvin Brown (DSMC)
Donna S. Ireton (NCMA)

Program Co-Chairs

Joan L. Sable (DSMC)
Patrick D. Sullivan (NCMA)

Program Committee

William Clark (DSMC)
Theodora Hancock (NCMA)

Arrangements: Dina A. Hyde (NCMA), Chair

Registration: Shirley Bass (NCMA), Chair

Registration Committee

Mary Burrell (NCMA)
Donette Cappello (NCMA)
Shelley L. Fink (DSMC)
Michael Fischetti (NCMA)

Breakout Session Moderators: Dr. Alma Davis (NCMA), Chair

Jim Abellera
Paul Ballou
Stan Crognale
Jay Gould
Beryl Harman
Edward Hirsch
Michael Krause
Elaine L. Larison
David Leising
Jack Livingston
Robert E. Lloyd
Jan Menker
Dr. Diane Murphy
Anthony Rymiszewski
Dr. Stanley Sherman
Dr. Ronald L. Straight

ACQUISITION RESEARCH SYMPOSIUM

Tuesday, June 22, 1993

0700-1630 Registration

0700-0825 Continental Breakfast

0830-0845 Welcome & Administrative Remarks:

Ms. Donna S. Ireton, Director of Contracts, Advanced Systems Development, Inc.

Mr. Patrick D. Sullivan, Assistant Vice President, Procurement & Finance, Aerospace Industries Association of America

0845-0945 Introduction: Colonel Claude M. Bolton, Jr., Commandant, Defense Systems Management College

Keynote Address: James A. McDivitt, Senior Vice President, Government Operations & International, Rockwell International Corporation

0945-1010 Break

1010-1100 Introduction: Colonel Claude M. Bolton, Jr.

Guest Speaker: Thomas J. Dolan, Jr., Holder of Acquisition Law Chair, Defense Systems Management College

1110-1200 Breakout Session #1

Conference Theatre (Room # 1)

Laberge: "Restructuring DOD: Study the High-Tech Commercial World"

Parklawn (Room # 2)

Sanders: "Achieving Public Ends with Private Means: The Government's Acquisition of R&D from FFRDCs"

Woodmont (Room # 3)

Bowes: "A New Beginning: Acquisition Planning with Software Reuse"

Halpine (Room # 4)

Quintela: "Innovations in Support Service Contractor Award Fee Performance Evaluation Process"

1200-1330 Lunch

Introduction: Mr. Patrick D. Sullivan

Guest Speaker: Mr. Steven K. Conver, Vice President, Operations Integration, Martin Marietta Corporation

1330-1420 Breakout Session #2

Conference Theatre (Room # 1)

Brandt: "DoD's New Senior Acquisition Course: A First Year Report"

Parklawn (Room # 2)

Alberts: "The Uncertain Validity of Research Results"

Woodmont (Room # 3)

Clark: "Modeling and Simulation for Source Selection Boards"

Halpine (Room # 4)

Lamm: "Application of a Taxonomical Structure for Classifying Federal Government Goods"

1430-1520 Breakout Session #3

Conference Theatre (Room # 1)

Johnson: "Virtual Prototyping - Concept to Production"

Parklawn (Room # 2)

Briskin: "Salvaging the Defense Industrial Base"

Woodmont (Room # 3)

Schoen: "Perspectives on the Use of Modeling & Simulation (M&S) in the Acquisition Process"

Halpine (Room # 4)

Lemmer: "Acquisition for Experimental or Test Purposes (AETP)"

1520-1540 Break (snack)

1540-1630 Breakout Session #4

Conference Theatre (Room # 1)

Abellera: "National Resources for Defense Research"

Parklawn (Room # 2)

Krieger: "Prerequisites for the Establishment of a Professional Acquisition Workforce, Revisited"

Woodmont (Room # 3)

Trottman: "Electronic Data Interchange (EDI) - The Gateway to Business in the 21st Century"

Halpine (Room # 4)

Wells: "Supporting a War: An Analysis of Contracting Support During Operations Desert Shield/Storm"

1700-1830 Reception (Atrium)

Wednesday, June 23, 1993

0730-0825 Registration and Continental Breakfast

0825-0830 Administrative Remarks:

Calvin Brown, Deputy Director, Research and Information, Defense Systems Management College

0830-1030 Joint Logistics Commanders Panel

Introduction: Colonel Claude M. Bolton, Jr.

Moderator: Vice Admiral William C. Bowes, Commander, Naval Air Systems Command

Panelists: Major General James A. Brabham, Jr., Commander, Marine Corps Systems Command

Darold L. Griffin, Principal Deputy for Acquisition, Headquarters, Army Materiel Command

Rear Admiral Leonard Vincent, Commander, Defense Contract Management Command

Colonel Harry H. Heimple, Deputy Director for Requirements, Air Force Materiel Command

1030-1100 Break

1100-1150 Breakout Session #5

Conference Theatre (Room # 1)

Sherman: "Source Selection Criteria: A Comparison of Private Sector and Government Buying Practices"

Parklawn (Room # 2)

Fowler: "Evolving Criteria for Evaluation: The Challenge for the International Integrator of the 90s"

Woodmont (Room # 3)

Thiel: "Image Management and Acquisition for the Future"

Halpine (Room # 4)

Lloyd: "The Concept of Value in Government"

1200-1330 Lunch

Introduction: Mr. Patrick D. Sullivan

Guest Speaker: Ms. Deborah L. Wince-Smith, Senior Fellow, Council on Competitiveness; former Assistant Secretary of Commerce for Technology Policy

1330-1420 Breakout Session #6

Conference Theatre (Room # 1)

Straight: "Evaluating Acquisition Practices: A Winning Strategy"

Parklawn (Room # 2)

Gale: "Customer Satisfaction in Defense Acquisition"

Woodmont (Room # 3)

Dahn: "A People-to-Hardware Decision Support System for Systems Acquisition"

Halpine (Room # 4)

Tyson: "Cost and Schedule Experience for Ground Combat and Ship Acquisition Programs"

1430-1520 Breakout Session #7

Conference Theatre (Room # 1)

Garrett: "Innovative Approaches to Creating, Allocating, and Implementing Award Fees in Systems Acquisition"

Parklawn (Room # 2)

Hooker: "From Budget to Award: Acquisition Process Flow Analysis"

Woodmont (Room # 3)

Murphy: "Implementing the Procurement Information Network: The Intelligent Gateway"

Halpine (Room # 4)

Green: "Activity-Based Costing: Is It Viable for Defense Acquisition Programs in the 90s?"

1520-1540 Break (snack)

1540-1630 Breakout Session #8

Conference Theatre (Room # 1

Lamm: "Simulated Negotiations: A Measure of their Effectiveness on Negotiated Outcome"

Parklawn (Room # 2)

Gadeken: "Developing Future Acquisition Managers with Behavioral Simulations"

Kehrt: "A Review of Factors Impacting Warranty Cost-Benefit Analyses for Dormant Weapon Systems"

Woodmont (Room # 3)

Perchik: "Materiel Acquisition - Process Definition"

Thursday, June 24, 1993

0730-0825 **Continental Breakfast**

0825-0830 **Administrative Remarks:** Ms. Donna S. Ireton

0830-1000 **International Aspects of Acquisition Panel**

Introduction: Mr. Patrick D. Sullivan

Moderator: Mr. John S. Autry, Executive Vice President, Susan Davis International & Public Affairs Group

Panelists: Mr. Hideaki Domichi, Economic Counselor, Embassy of Japan

Mr. Galen I. Ho, Vice President and General Manager, Merlin Programme; President and Chief Executive Officer, IBM-Aerospace Systems Integration Corp. Subsidiary

Mr. Gerhard J. Lohan, Head of Trade Section, Delegation of the Commission of the European Communities

Ms. Laura Sherman, Assistant General Counsel, U.S. Trade Representative

1000-1030 **Break**

1030-1200 **The Industrial Base - Progress or Poverty?**

Introduction: Colonel Claude M. Bolton, Jr.

Moderator: Mr. Patrick D. Sullivan

Panelists: Ms. Cathleen D. Garman, Professional Staff Member, Committee on Armed Services, U. S. House of Representatives

Mr. Richard C. Barnard, Assistant Vice President, Army Times Publishing Company; Executive Editor, Defense News, Space News, Commercial Aviation News

Mr. Nicholas M. Torelli, Jr., Former Deputy Assistant Secretary of Defense for Production Resources

Dr. James Blackwell, Assistant Director, Science Applications International Corporation Strategic Assessment Center

1200 **Symposium Adjourns**

JOHN S. AUTRY

Executive Vice President
Susan Davis International & Public Affairs Group

John S. Autry, Executive Vice President of Susan Davis International & Public Affairs Group has over 30 years of experience in government relations, marketing, communications, international trade, environmental safety, human resources, and management. Through his work on these international and domestic issues, Mr. Autry has maintained close working relationships with the leaders of Congress, several Administrations, as well as foreign governments throughout Europe and Asia.

Mr. Autry was for ten years Vice President of Government Relations and International Trade at the Unisys Corporation in Washington, D.C., where he developed and managed the corporation's Congressional relations and international trade programs. In this role, he was responsible for advancing and protecting Unisys political interests as a multinational enterprise engaged in high technology and diverse growth industries; for implementing employee Congressional grassroots communications programs involving 120 managers in 36 states; and for developing Unisys corporate identity. He is past president of the Business Government Relations Council of Washington and currently serves on the Board of Directors of the World USO, the National Multiple Sclerosis Society and is an active member of the Washington Board of Trade's Government Relations Committee.

Prior to joining Unisys, Mr. Autry was Vice President and Director of Public Affairs for the Johns Manville Corporation. He was responsible for developing international trade programs between the U.S. Government and several foreign governments. Subsequently, as Vice President for Marketing at Johns Manville, Mr. Autry organized and managed national and international customer marketing programs and directed international sales and licensing programs. He was also responsible for engineering, marketing, and customer operations in New York, Washington, DC, Los Angeles, and Denver.

Before joining Johns Manville in 1960, Mr. Autry was the City Manager and the Public Works Director for the City of Ojai, CA.

A distinguished military graduate of the Virginia Polytechnic Institute, Mr. Autry holds a Bachelor of Science degree in Civil Engineering. He attended graduate school at Stanford University, and the University of Southern California, where he received his Masters of Science degree in Political Science.

RICHARD C. BARNARD

Vice President
Army Times Publishing Company

Rick Barnard is a vice president of Army Times Publishing Co., and executive editor of *Defense News*, *Space News* and *Commercial Aviation News*, weekly international newspapers about political and business issues, foreign trade, national security policies and aerospace technologies. The three newspapers comprise the company's News Business Publications division.

Mr. Barnard was born in Alabama in 1943, and began his journalistic career in 1967 as a reporter for *The Sun Sentinel*, a daily newspaper in Fort Lauderdale, FL.

He joined the Army in 1969 and was assigned to the Defense Intelligence Agency in Washington. After his discharge, he worked as a researcher and writer for Ralph Nader and in 1973 joined the Army Times Publishing Co. as a magazine writer and Pentagon correspondent. In 1980, he became the founding editor of *Defense Week*, a newsletter about national security issues and military weapons.

In December 1984, Barnard rejoined the Army Times Publishing Co. as editor of *Navy Times*, a weekly newspaper on personnel policy and other defense subjects. In August 1985, he became founding editor of *Defense News* and later was named its executive editor.

In June 1989, Barnard helped create *Space News* and became its executive editor. In March 1992, he became executive editor of *Commerce Aviation News* which began weekly publication in January 1993.

Barnard has received the National Press Club award for excellence in consumer reporting for his reports about insurance sales in the military community.

He is a speaker and commentator, and has appeared on the CBS news shows 60 Minutes and Nightwatch, the PBS show LateNite America, The Larry King Show, CBS's Sunday Morning and NPR's All Things Considered. His articles have appeared in the *Los Angeles Times*, *Vital Speeches* and other publications. Barnard has spoken before such groups as the World Affairs Council of Los Angeles, the American Association of Political Consultants, the National Defense University and the Channel City Club of Santa Barbara, CA.

He holds a M.A. in communications from the American University in Washington, DC and a B.A. in political science from Florida Atlantic University in Booa Raton, FL.

Mr. Barnard lives in Springfield, VA with his wife, Marjorie Elizabeth, and his sons, Samuel and William.

DR. JAMES BLACKWELL

Assistant Director
Science Applications International Corporation
Strategic Assessment Center

Dr. James Blackwell is the Assistant Director of Science Applications International Corporation (SAIC) Strategic Assessment Center.

A specialist in military technology, doctrine, and operations, Dr. Blackwell served previously as a Division Operations Officer in the U.S. Army and has taught at the U.S. Military Academy at West Point.

Prior to joining SAIC, he directed projects on defense reorganization, congressional oversight of defense, the defense industrial base, and conventional warfare at the Center for Strategic and International Studies (CSIS). Dr. Blackwell currently serves as co-chair of the Project on Persian Gulf War Military Lessons Learned. He is also the author of Thunder in the Dessert: The Strategy and Tactics of the Persian Gulf War, published by Bantam/Doubleday. He has testified before the Senate Armed Services Subcommittee on Defense Industry and Technology, the House Banking Subcommittee on Economic Stabilization, and the House Armed Services Committee. His articles have appeared in *Parameters, Military Technology, NATO's 16 Nations*, and *National Defense*, and he has contributed to numerous books and edited volumes. He is co-editor, with Barry Blechman, of *Making Defense Reform Work* which was published in the Spring of 1990. He has appeared on network television and radio worldwide and served as CNN's military analyst during the Persian Gulf crisis. His comments are quoted regularly in newspapers and magazines such as *The Washington Post, U.S. News and World Report, People Magazine, The Wall Street Journal, The Economist,* and *The Boston Globe*. His op-eds have appeared in *The Washington Post*, the *San Diego Union*, and *The Chicago Tribune*.

Dr. Blackwell earned his Ph.D. in International Security Studies at the Fletcher School of International Law and Diplomacy, Tufts University, in 1985.

COLONEL CLAUDE M. BOLTON, JR., USAF

Commandant, Defense Systems Management College

Colonel Claude M. Bolton, Jr., assumed command of the Defense Systems Management College on March 25, 1993.

Colonel Bolton was born December 13, 1945, in Sioux City, IA, and graduated from South Sioux City High School, South Sioux City, NE. He earned a bachelor's degree in electrical engineering from the University of Nebraska in 1969, and was commissioned a second lieutenant as a distinguished graduate of the Air Force Reserve Officer Training Corps program there. In 1978, he earned a master's degree in management from Troy State University, Troy, AL, and completed course work for a Ph.D. in electrical engineering at the University of Florida. He completed Squadron Officer School in 1974, Air Command and Staff College and the Defense Systems Management College in 1982, and the Naval War College in 1986. In 1991, he earned a second master's degree in national security and strategic studies from the Naval War College.

The colonel was assigned to Williams Air Force Base, AZ, for pilot training and received his wings in 1970. He then was assigned to McConnell Air Force Base, KS, and flew the F-105D aircraft. He later transitioned to the F-4 aircraft.

In June 1971, Colonel Bolton was assigned to Ubon Royal Thai Air Force Base, Ubon, Thailand, flying F-4D/E for the 497th Tactical Fighter Squadron (Nite Owls). While at Ubon, he flew 232 combat missions -- 40 over North Vietnam -- including the first missions after the bombing of North Vietnam was resumed. In 1972, he was assigned to Cannon Air Force Base, NM, where he flew the F-111D aircraft and served as an instructor pilot and safety officer.

In 1974, he was assigned to the 55th Tactical Fighter Squadron, Royal Air Force, Upper Heyford, England, as an F-111E pilot. While there, he served as the squadron and wing safety officer, instructor pilot, and wing standardization/evaluation flight examiner and scheduler.

In 1977, Colonel Bolton attended the Air Force Test Pilot School at Edwards Air Force Base, CA. Following graduation, he was assigned to the 3245th Test Wing at Eglin Air Force Base, FL, as a test pilot flying the F-4, F-111, and F-16. He also was the F-111 flight test manager for the Armament Division there. In 1982, he was assigned to Aeronautical Systems Division, Wright-Patterson Air Force Base, OH, as the first program manager for the Advanced Tactical Fighter Technologies Program, which evolved into the F-22 System Program Office.

In 1986, the colonel was assigned to the Pentagon, Washington, D.C., first as the F-16 program element monitor and deputy division chief, Aircraft Division, and later as the division chief, Low Observables Vehicle Division, Office of Special Programs. He returned to the Aeronautical Systems Division as deputy program director for the B-2 System Program Office in August 1988. In August 1989, he became program director for the Advanced Cruise Missile System Program Office, Aeronautical Systems Division, Air Force Systems Command. He assumed the position of Inspector General, Headquarters Air Force Materiel Command, Wright-Patterson Air Force Base, OH, in September 1992.

VICE ADMIRAL WILLIAM C. BOWES, USN

Commander, Naval Air Systems Command

Vice Admiral William Bowes, a native of New York, graduated from the University of Idaho and its NROTC Regular Program in June 1963. He is a 1968 graduate of the United States Naval Test Pilot School and received his masters degree in systems management from the Naval Postgraduate School in March 1974.

Upon receiving his wings in December 1964, he joined the light attack community at the Naval Air Station, Lemoore, CA. He served with VA-113 flying A-4's and later with VA-94 flying A-7's on combat missions from the USS KITTY HAWK (CV 63), USS ENTERPRISE (CVN 65), and USS CORAL SEA (CV 43). Vice Admiral Bowes flew 350 combat missions in Southeast Asia between 1965 and 1972. He served with the VA-195 Dambusters from August 1976 until December 1979 as Executive Officer and then as Commanding Officer. During this time he operated with both the Pacific and the Atlantic fleets from USS KITTY HAWK and the USS AMERICA (CV 66).

An experienced test pilot, Vice Admiral Bowes has had three tours at the Naval Air Test Center, Patuxent River, MD. He has served as an engineering test pilot in the Carrier Suitability Branch, an instructor and operations officer at the Test Pilot School, and as the Director, Systems and Engineering Test Directorate. Having piloted every jet aircraft that has been in the fleet since the 1960's, he has flown more than 5,000 hours in over 50 different U.S. and foreign military aircraft. He has also accumulated 900 carrier-arrested landings and more than 150 carrier touch-and-go landings during his operational tours and during carrier suitability testing. He is an associate fellow in the Society of Experimental Test Pilots.

Vice Admiral Bowes began his program management experience in January 1980 in the Naval Air Systems Command, as the F/A-18 Assistant Program Manager for Systems and Engineering. In December 1983, he was assigned as the F-14 Aircraft and Phoenix Missile System Program Manager. He managed the Phoenix missile system until June 1985 and the F-14 until November 1987. During that tour of duty the F-14A (PLUS) and the F-14D programs were initiated and the first production F-14A (PLUS) was delivered to the Navy.

He was promoted to Rear Admiral in November 1987, at which time he was assigned as the Director, Cruise Missiles Project. In May 1988, he was given an additional responsibility and became the first director of the Unmanned Aerial Vehicles Joint Project. In April 1990 he was designated the Program Executive Officer for the Cruise Missiles Project and the Unmanned Aerial Vehicles Joint Project.

In March 1991, Vice Admiral Bowes became the Commander of the Naval Air Systems Command.

MAJOR GENERAL JAMES A. BRABHAM, JR., USMC

Commander, Marine Corps Systems Command

Major General James A. Brabham, Jr., is currently serving as the Commander, Marine Corps Systems Command, Quantico, VA.

General Brabham was born August 31, 1939 in Upper Darby, PA. He received his commission in June 1962 following graduation from Cornell University, where he earned a Bachelor of Civil Engineering degree.

In December 1962, after completing The Basic School at Quantico, VA, he was assigned to the 1st Marine Division, Camp Pendleton, CA., where he served as a platoon leader in the 1st Bridge Company, FMF, Pacific. He commenced a two-year tour of duty at the Marine Barracks, Pearl Harbor in 1964, serving as guard officer and barracks personnel officer. He reported to the 1st Shore Party Battalion in Chu Lai, Vietnam in August 1966, where he served as Commanding Officer of Company A, and subsequently Commanding Officer of Headquarters and Service Company.

From August 1967 to July 1968, he attended the U.S. Army Engineer School, Fort Belvoir, VA. Upon graduation, he was assigned to Headquarters Marine Corps, Washington, D.C., for duty as the Engineer Equipment Programming Officer in the Office of the Assistant Chief of Staff (G-4).

Ordered back to Vietnam in April 1971, he served as the Engineer Advisor to the Vietnamese Marine Corps, remaining in that capacity through the North Vietnamese Easter offensive of April 1972.

Upon reassignment to Twentynine Palms, CA., he assumed command of Provisional Maintenance Company, Force Troops, FMF Pacific. He commanded that unit until assignment to the U.S. Naval Academy in August 1975. During his tour at the Naval Academy, he served as a Company Officer, Instructor of Leadership, and Executive Assistant to the Commandant of Midshipmen.

Returning overseas in August 1978, he served as Executive Officer of Camp Garcia, Vieques, Puerto Rico, until December 1978.

General Brabham's next assignment was as the Program Coordinator for the Air Cushion Landing Craft Development and Acquisition Program on the staff of the Chief of Naval Operations, Washington, D.C. On July 2, 1981, he assumed command of the 2d Combat Engineer Battalion, Camp Lejeune, NC, and commanded that unit until July 1983, when he was assigned duties as the Assistant Chief of Staff, G-4, 2d Marine Division.

From August 1984 until July 1986, General Brabham was assigned duties as the Assistant Chief of Staff, G-4, II MAF, Camp Lejeune, NC. General Brabham was next assigned as the Deputy Director for Logistics, J-4, USCENTCOM, MacDill AFB, FL. While serving in this capacity, he was selected for promotion to Brigadier General in November 1988. He was advanced to Brigadier General on June 23, 1989, and was assigned duty as the Commanding General, 1st Force Service Support Group, FMF, Camp Pendleton, CA, on July 14, 1989. He commanded that Unit during its participation in Operations Desert Shield and Desert Storm. On July 8, 1991, he was assigned duty as Director, Marine Air-Ground Training and Education Center. He was advanced to his present grade on March 10, 1992, and assumed his current assignment on June 29, 1992.

STEPHEN K. CONVER

Vice President, Operations Integration
Martin Marietta Corporation

On January 11, 1993, Stephen K. Conver joined Martin Marietta Corporation as Vice President, Operations Integration. Prior to that time, he served for three years as the Assistant Secretary of the Army for Research, Development and Acquisition. In that capacity, Mr. Conver functioned as the Army Acquisition Executive, with responsibility for Research, Development, Test and Evaluation programs; procurement programs; Army acquisition policies and procedures; and worldwide security assistance programs.

Mr. Conver previously served on the professional staff of the House Armed Services Committee as the principal defense advisor to Congressman Bill Dickinson (the Ranking Republican) and the 21 other Republican Members of the Committee. Prior to joining the HASC in 1985, Mr. Conver served for four years on the staff of the Secretary of the Air Force as Deputy Assistant Secretary (Programs and Budget). In this position, he was responsible for overseeing the development, approval and execution of the Service budget. Between 1975 and 1981, Mr. Conver held several positions with the United States Nuclear Regulatory Commission, beginning as an operations analyst and progressing to Chief of Analysis and Planning for the Agency.

After receiving his Bachelor of Science Degree from the U.S. Air Force Academy in 1966, Mr. Conver served for nine years as a commissioned officer in the Air Force. He earned a Master's Degree in Operations Research from Ohio State University in 1970. Mr. Conver's military experience covered a broad range of subjects, including long-range planning studies in support of advanced weapons acquisitions, technical analysis of Soviet weapon systems, and analysis of U.S. strategic force structure.

Mr. Conver was born in Memphis, TN and raised in Cincinnati, OH. He and his wife Nan presently reside in Great Falls, VA.

THOMAS J. DOLAN, JR.

Holder of Acquisition Law Chair
Defense Systems Management College

Mr. Dolan is the Acquisition Law Chair at the Defense Systems Management College. In this position, he is providing support to OSD and the Congress in the legislative review of the Section 800 Panel's recommendation.

Mr. Dolan is a native of Boston, MA. He graduated from the College of The Holy Cross and received his law degree from Suffolk University Law School. After military service in the U.S. Army, Mr. Dolan started his civilian career with the Office of Naval Research (ONR), Boston, MA, in the administration of research and development contracts/subcontracts with universities, nonprofit, and commercial organizations. Subsequently, he joined the staff of the ONR Office at the Massachusetts Institute of Technology as a contracting officer with administrative oversight responsibilities for advanced research and development programs at the Draper Laboratory.

In 1971, he was assigned as the resident representative for all DOD programs at Harvard University. In addition to his business management responsibilities at the University, Mr. Dolan undertook a special assignment to streamline procedures for performing contractor procurement system reviews.

In 1979, Mr. Dolan transferred to ONR Headquarters to head up the Acquisition Plans, Policy and Evaluation Branch. During this assignment, he was appointed Chairman of the Noncommercial Cost Principles subcommittee of the DAR Council. In 1983, Mr. Dolan was detailed as a special assistant to the Office of the Under Secretary of Defense (Research and Advanced Technology) to provide support on research acquisition policy matters with special emphasis on DOD's Independent Research and Devclopment Program.

Upon his appointment to the Senior Executive Service in 1985, Mr. Dolan became Director of the University Business Affairs Directorate in ONR. In this position he was the senior line manager of the ONR Field Contract Administration Organization and the principal executive for the formulation and development of effective business systems. During this period, Mr. Dolan organized and directed four major administrative initiatives--The Federal Demonstration Project, the Navy's Electronic Funds Transfer Program, the University Coordinated Audit Program and the Patent Surveillance Program. These programs have become operational procedures in the field administration of research programs.

In 1991, he undertook a senior executive assignment at the Defense Systems Management College (DSMC) to provide acquisition advice, counsel and support to the DSMC Commandant, Navy Chair, and faculty and students. During this period, he provided expert support to the Acquisition Law Advisory Panel in their efforts to streamline and codify DoD acquisition laws.

Mr. Dolan has been awarded the Presidential Rank of Meritorious Executives in the SES, the Navy Meritorious Civilian Service Award, and the National Leadership Award from the National Grants Management Association.

Mr. Dolan is a member of the Massachusetts Bar, and a Certified Professional Contracts Manager. He attended the Federal Executive Institute and the Program for Senior Managers in Government at the Kennedy School of Government. He resides with his wife, Sally, in Fairfax, VA.

MR. HIDEAKI DOMICHI

Economic Counselor
Embassy of Japan

Mr. Domichi has served as Economic Counselor to the Embassy of Japan, Washington, D.C. since March 1992.

Mr. Domichi previously held several positions with the Ministry of Foreign Affairs. His positions included serving as the Director for the East Europe Division from 1990 to 1992; Director for the Second African Division, 1988-1990; and Senior Advisor for the Policy Division of the Economic Cooperation Bureau, 1987-1988. In addition, he was in charge of the Tokyo Summit (G7) for the International Press Division in 1986-1987.

Earlier, Mr. Domichi served as the First Secretary to the Embassy of Japan in the United Kingdom and as the First Secretary to the Embassy of Japan in Thailand.

Mr. Domichi also held the following positions during earlier employment with the Ministry of Foreign Affairs: Deputy Director for the Second Middle East Division; Officer for the First North America Division; and as Officer of the Office of Law of the Sea Conference.

Mr. Domichi graduated from Cambridge University, United Kingdom in 1975 and from Tokyo University in 1972.

CATHLEEN D. GARMAN

Professional Staff Member
Committee on Armed Services
U.S. House of Representatives

Ms. Garman received her MA in Administrative Sciences (Management Information Systems) from George Washington University and her BA in Political Science and Journalism from the University of Wisconsin. Since joining the House Armed Services Committee in 1990, Ms. Garman has participated in the development of numerous acquisition improvement measures, such as the provisions adopted as part of the annual Defense Authorization Acts (including the Defense Acquisition Workforce Improvement Act). She has also helped develop policies relating to the Defense Department drug interdiction program.

Prior to her present assignment, Ms. Garman worked on the House Small Business Committee and was responsible for developing legislation related to general small business procurement and innovation (including minority business development reform and the Small Business Innovation Research program).

Ms. Garman began her career on Capitol Hill as a legislative assistant for former Congressman Nicholas Mavroules and subsequently served as his Chief of Staff. Ms. Garman also has served two years in the Philippines as a Peace Corps Volunteer.

DAROLD L. GRIFFIN

Principal Assistant Deputy for Research, Development and Acquisition
Army Materiel Command

Darold L. Griffin was born on September 4, 1931, in Rensselaer, IN. He attended the University of Cincinnati, receiving a degree in Metallurgical Engineering in 1954. Subsequent to that, he also completed a law program in conjunction with LaSalle University.

In 1955, after a year in private industry, Mr. Griffin was inducted into the Army and was assigned to Picatinny Arsenal as a Scientific and Engineering Specialist.

Mr. Griffin joined the Federal Service at Picatinny in 1957 as an Engineer in the Industrial Engineering Division. He has held successively more important positions in conventional and nuclear munitions resulting in his selection as Assistant Director for Engineering and Production Base Modernization and Expansion in the Munitions Command's Procurement and Production Directorate in 1969. In 1970 he became the Deputy Director of the Munitions Command's new Manufacturing Technology Directorate and in January 1973, was selected as the Deputy Project Manager for Munitions Production Base Modernization and Expansion.

In January 1979, he joined Army Materiel Command Headquarters as Chief of the AMC Manufacturing Technology Office. He became the Associate Director for Systems Development in August 1980 and Assistant Deputy Chief of Staff for Development, Engineering, and Acquisition in October 1981. In July 1985, Mr. Griffin became the Deputy Chief of Staff for Production. In December 1989, he became the Principal Assistant Deputy for Research, Development and Acquisition, HQ, AMC. He currently is the Principal Deputy for Acquisition for Headquarters, AMC, a position he has held since August of 1992.

Mr. Griffin's activities and contributions to the Department of the Army have earned him three Meritorious Civilian Service Awards, Presidential Rank of Meritorious Senior Executive, a listing in Who's Who in Finance and Industry, and numerous other awards and honors. He is active in several professional societies and organizations including the American Society for Metals, the Professional Division of Alpha Chi Sigma Fraternity, the American Defense Preparedness Association, and is a past member of the Stanhope, New Jersey Board of Education.

Mr. Griffin is married to the former Arlene C. Papke. They have five children and reside in Fairfax Station, Virginia.

COLONEL HARRY H. HEIMPLE, USAF

Deputy Director for Requirements
Headquarters Air Force Materiel Command

Colonel Harry H. Heimple is the Deputy Director for Requirements, Headquarters Air Force Materiel Command, Wright-Patterson Air Force Base, OH.

Colonel Heimple was born September 7, 1945, in Wichita, KA. He graduated from Fremont High School in Sunnyvale, CA, in 1963, and from Stanford University in 1967, majoring in physics. He earned a master of science degree in astrophysics from Ohio State University in 1969. He was commissioned a second lieutenant in 1967; completed Squadron Officer School in 1976; and completed the French Test Pilot School in 1977. He was also a distinguished graduate of the French Air War College and French National War College in 1986.

After completing graduate school, Colonel Heimple began active duty in 1969, attending pilot training at Vance Air Force Base, OK. He then completed advanced fighter training in F-4's at Davis Monthan Air Force Base, AZ, and was assigned in 1971 to the 80th Tactical Fighter Squadron at Kunsan Air Base, Korea.

The colonel was assigned to the 388th Tactical Fighter Wing, Korat Air Base, Thailand, in 1972, and flew 232 combat missions in F-4E's, 112 of which were flown over North Vietnam.Colonel Heimple was assigned to the 58th Tactical Fighter Wing, Luke Air Force Base, AZ, in 1973, as an instructor pilot in the F-4 and also served on the wing staff.

Colonel Heimple attended the French Test Pilot School at Istres, France, in 1976, and graduated number one in his class in July 1977. He returned to Edwards Air Force Base as an instructor in the U.S. Air Force Test Pilot School for two years and then served as operations officer for the F-16 Combined Test Force. In 1981, the colonel became commander of the Advanced Fighter Technology Integration F-16 Joint Test Force, a joint USAF/NASA program.

After completing the French War Colleges in March 1986, the colonel was assigned to the Directorate of Operational Requirements, Office of the Deputy Chief of Staff for Research, Development and Acquisition, Air Force headquarters. In May 1987, Colonel Heimple assumed command of the Avionics and Special Programs Division, Directorate of Electronic Combat, Assistant Secretary of the Air Force for Acquisition. In September 1988, he became deputy program director for the Joint Surveillance Target Attack Radar System Program Director (JSTARS) at Hanscom Air Force Base, MA. A year later, he became the System Program Director for the Joint STARS program.

Colonel Heimple assumed his current position in January 1993.

GALEN I. HO

President and Chief Executive Officer
IBM - Aerospace Systems Integration Corp.

In 1993, Mr. Ho was named IBM-FSC Vice President and General Manager of the Merlin Programme responsible for the entire project and project team in the United Kingdom. He is also President and Chief Executive Officer of the IBM-Aerospace Systems Integration Corporation Subsidiary responsible for aerospace business development opportunities arising from this program in Europe established to pursue and conduct business throughout the United Kingdom and Europe. Mr. Ho is currently based in IBM, North Harbour, England.

In 1988, Mr. Ho was named Assistant General Manager, Programs at IBM Federal Sector Division's Owego, NY facility. In this position, he has responsibility for all Aerospace Development/Production Programs including the Navy's LAMPS MK III; the Air Force's Combat Talon II, F-15 Aircraft, and NATO E-3 Aircraft; and the Army's Special Operations Aircraft (ASOA) and Communications High Accuracy Airborne Location System (CHAALS). He oversees over 50 programs with approximately 200 active contracts as well as directs all the business development activities necessary to define strategies for future sales in the Owego Site.

Mr. Ho was named Assistant General Manager, Systems Programs in September 1986. His responsibilities included avionics systems development for programs such as LAMPS MK III, Combat Talon II, HH-60A, LXH/ARTI, V-22 Avionics Subsystem, and MH-531. He also managed the System Engineering Practices Development for the Owego facility.

In 1984, Mr. Ho was promoted to Program Director, Processor Systems Programs with responsibility for directing all new avionics computer development programs and managing all on-going avionics computer programs from development through production phases.

The 1981, he was named Assistant to the IBM-FSD President, responsible for Technical and Administrative Management within the President's office.

From 1974 to 1981, he held various management jobs which included responsibility for the Radar Weapon Data Link Program, Joint Tactical Information Distribution System (JTIDS) Expendable Terminal Development, Product Definition of Military Processor Systems, and Business Area Strategies for both FSD Owego's Processor Systems and Communication Systems Programs.

Mr. Ho joined IBM in 1972 as a Staff Engineer in Tactical Avionics Systems at IBM's Federal Systems Division plant in Owego. He was appointed Manager of Advanced Navigation and Strike Systems at Owego in 1974.

Prior to Mr. Ho's employment at IBM, he was an officer in the U.S. Air Force assigned to the Aeronautical Systems Division responsible for Processor Subsystems Development. He attained the rank of Captain and holds awards for Vietnam Combat Service and the Meritorious Service Medal.

Mr. Ho received a BSEE from Oregon State and did graduate studies at Ohio State.

GERALD J. LOHAN

Head of Trade Section
Delegation of the Commission of the European Communities

Gerhard Lohan is Counselor for trade and commercial affairs at the Delegation of the Commission of the European Communities. He took up this post on 1 September 1992.

Before, he worked for 13 years for the Commission in its Brussels headquarters, of which three years were spent in the Directorate General for External Relations (DG I) and ten years in the Directorate General for Internal Market and Industrial Affairs (DG III).

His job experience includes trade policy of the European Communities (EC) with Japan, and responsibilities in the field of motor vehicle industry policy. In the context of the "Internal Market - 1992" objective, Mr. Lohan was closely involved in the legislative program concerning public procurement.

More recently, he was in charge of coordination of DG III's position on competition policies, with particular emphasis on anti-trust matters and merger control.

In the Washington Delegation, Mr. Lohan's responsibilities comprise EC/US bilateral trade and commercial policy affairs, as well as multilateral matters.

Mr. Lohan has studied law in Germany and worked as manager of a foreign trade association before joining the EC Commission. He resides in Washington with his wife Kristin and their three boys, Malte, Felix and Jesco.

JAMES A. McDIVITT

Senior Vice President
Government Operations & International
Rockwell International Corporation

James A. McDivitt was appointed senior vice president, government operations and international for Rockwell International Corporation in November 1990. He is a corporate officer and a member of the company's management committee.

Mr. McDivitt has held a series of executive positions with Rockwell including: senior vice president, Government Operations, executive vice president, Electronic Operations; executive vice president, Defense Electronics Operations; senior vice president of science and technology, and senior vice president for strategic management. He joined Rockwell in January 1981.

Prior to beginning his Rockwell career, Mr. McDivitt was executive vice president and a member of the board of directors of Pullman Inc., in Chicago. He joined that company in 1975.

Mr. McDivitt earlier was executive vice president and a director of Consumers Power Co. of Jackson, MI.

He entered the U.S. Air Force in 1951 and was commissioned in May 1952. He graduated from the U.S.Air Force Experimental Test Pilot School in March 1960 and the U.S. Air Force Aerospace Research Pilot Course in 1961.

In 1962, Mr. McDivitt was assigned to the National Aeronautics and Space Administration (NASA) as an astronaut. He was the command pilot for Gemini IV, the 66-orbit, four-day space mission in 1965; and commanded the Apollo 9 earth orbital flight in 1969. He established six world records for space flight. Mr. McDivitt was the Apollo Spacecraft Program Manager from 1969 to 1972, with overall management responsibility for Apollo 12 through 16. He retired from the Air Force in 1972 as a brigadier general.

Earlier in his military career, Mr. McDivitt flew 145 combat missions during the Korean War. His service decorations include two distinguished service medals, four distinguished flying crosses, five air medals and the Republic of Korea Chung Moo medal.

Born June 10, 1929, in Chicago, Mr. McDivitt received a bachelor of science degree in aeronautical engineering in 1959, and honorary doctor of astronautical science in 1965 from the University of Michigan. He was awarded honorary doctor of science degrees by Seton Hall University in 1969 and Miami University in 1970, and an honorary doctor of laws by Eastern Michigan University in 1975.

Mr. McDivitt serves on the advisory council of the University of Michigan College of Engineering. He is also the charter national chairman of the annual fund for the College.

Mr. McDivitt is a fellow of the Society of Experimental Test Pilots and the American Aeronautical Society. He is also a member of the American Institute of Aeronautics and Astronautics.

LAURA BETH SHERMAN

Assistant General Counsel
U.S. Trade Representative
Department of State

Ms. Sherman assumed the position of Assistant General Counsel, U.S. Trade Representative, Department of State in September 1992. Previously, she served as attorney-advisor to the Office of Ethics and Personnel, Office of the Legal Adviser, Department of State. In this position, she was the alternate designated agency ethics official, providing advice to department principals and all other employees on ethics and conflict of interest statutes and regulations, Hatch Act questions, nepotism, and other personnel issues.

Earlier, she served as Associate (Corporate) at Paul, Weiss, Rifkind, Wharton & Garrison in New York (1985 to 1990). Here, she was responsible for the preparation and negotiation of financing documents, acquisition agreements, joint venture contracts and licensing, technology transfer, employment and other commercial contracts; preparation of securities filings; advice to clients on general corporate matters; and pro bono activities for the Lawyers Committee for Human Rights and Helsinki Watch.

From 1982 to 1985, Ms. Sherman was a law clerk in the Office of International Claims and Investment Disputes, Office of the Legal Advisor, Department of State. She prepared Statements of Defense for claims filed against the U.S. to Iran-U.S. Claims Tribunal; prepared memorials on questions of interpretation of the Algiers Accords; and analyzed merits and recommendations for resolution of U.S. citizen claims against Egypt, Ethiopia, Romania, and other countries.

As country director for Papua, New Guinea, Foundation for the Peoples of the South Pacific, Port Moresby, Papua, New Guinea (1979 to 1981), Ms. Sherman was responsible for the administration of economic and social development projects with a total budget of $300,000 per year; proposal writing, evaluation and monitoring of projects; and providing technical services to project holders.

Ms. Sherman was a professional staff member of the Select Committee on Narcotics Abuse and Control, House of Representatives in 1979, where she coordinated Committee oversight hearings; performed legislative research and drafting; and drafted speeches and reports. Prior to that, she was administrative assistant to the Director, Institute of International Relations, translating (Chinese to English) and editing articles for the Institutes' journal and organizing international conferences.

Ms. Sherman received a J.D. degree (magna cum laude) in 1985 from Georgetown University Law Center; a Ph.D in 1978 from the University of Sofia, Bulgaria; and a B.A (cum laude) in 1973 from Cornell University with majors in Chinese studies and economics. She has also authored numerous publications.

PATRICK D. SULLIVAN

Assistant Vice President
Aerospace Industries Association of America

As Assistant Vice President, Aerospace Procurement Service, Aerospace Industries Association of America (AIA), Mr. Sullivan specializes in the areas of procurement, finance and contract management. His professional involvement in government contracting spans over 25 years.

Since joining AIA, Mr. Sullivan has been the association's project officer for a number of important legislative and regulatory issues affecting the aerospace industry, including Work Measurement, Independent Research and Development (IR&D), Material Management and Accounting Systems (MMAS), Drug Free Workforce/Workplace and Total Quality Management (TQM). He is the professional staff officer responsible for the AIA Legal Committee and the Facilities and Property Committee.

Prior to joining AIA, Mr. Sullivan was a Senior Associate with Harbridge House, Inc., where he provided consulting services, prepared instructional materials and presented programs on acquisition management for major defense contractors.

Prior to his association with Harbridge House, Mr. Sullivan served for four years as the Manager of Contracts and Long-Range Planning for Data-Design Laboratories. Earlier, Mr. Sullivan was a Vice President with Management Concepts, Inc. In this capacity, he taught procurement courses to employees of various civilian agencies.

Mr. Sullivan, who retired from the Navy with the rank of Captain, served in several staff positions involving the acquisition of major defense systems. Prior to his retirement, he was the Director of Weapons System Acquisition in the Office of the Deputy Under Secretary of Defense, Acquisition Policy, DDR&E.

Before being assigned to OSD, Mr. Sullivan served as Special Assistant for Weapons System Acquisition to the Deputy Commander of Contracts in the Naval Electronic Systems Command. He was also the Contracting Officer for the MARISAT program, which was the first government lease of a commercial communications satellite.

Other Navy Assignments included serving as Chief, Operations Branch, Defense Contract Administration Services (DCAS) Headquarters. While at DCAS, he was loaned for a year to the congressional Commission on Government Procurement, where he was a member of the Reports and Management Control Systems study group.

Mr. Sullivan has held the position of Contracts and Materials Officer in the office of the Supervisor of Shipbuilding, Overhaul and Repair at Bath Iron Works.

Mr. Sullivan has been an adjunct professor with the American University Kogod School of Business Administration where he taught Major Systems Acquisitions. He is a Certified Professional Contracts Manager, a Fellow, National Contract Management Association, and a member of the National Property Management Association.

Mr. Sullivan holds a B.S. degree in education from Miami University and a Masters degree in business administration from Harvard Business School.

NICHOLAS M. TORELLI, JR.

Consultant

Nicholas M. Torelli, Jr. served as the Deputy Assistant Secretary of Defense for Production Resources from November 1990 until February 1993. He was responsible for policy development, implementation and oversight of production resources for weapons systems, including production readiness, quality, manufacturing modernization, specifications and standards, and the industrial base. Mr. Torelli was the principal architect in formulating the DoD acquisition strategy in its relationship to the capabilities of the industrial base supporting national defense.

Mr. Torelli graduated from the U.S. Naval Academy and the Navy Nuclear Power Training Curriculum before serving in the Navy aboard Attack Submarines. He then spent 12 years in the defense industry in leadership positions in systems engineering, production management and program management providing tactical missiles and combat systems to the Army, Navy, and Air Force.

In his most recent industry position, Mr. Torelli played a major role in the turnaround of a weapons systems manufacturing division. He was instrumental in developing a culture of "Quality First" within the division workforce, establishing guidelines for transition of programs from development into production, helping to establish a "gainsharing" program for employee involvement in division success, and leading an organizational development team in overhauling the division's procedural system.

Mr. Torelli is currently employed as a private consultant to industry, providing services in industrial base policy, strategic planning, quality, and the integration of products and processes for systems development.

REAR ADMIRAL LEONARD VINCENT, SC, USN

Deputy Director - Acquisition
Commander, Defense Contract Management Command

Since December 1992, in his role as deputy director for acquisition management, Admiral Vincent has been responsible for oversight of DLA's $12 billion procurement operations executed by 3,800 procurement personnel located throughout the Agency and for its 19,000-person contract administration organization. Defense Contract Management Command, initiated to streamline contract management, consolidates virtually all defense contract administration worldwide, and administers contracts, accepts quality products and pays the contractors on behalf of all soldiers, sailors, airmen and Marines.

Rear Admiral Vincent entered the Naval Reserve program as a seaman recruit in October 1961. Upon graduation from Southeastern State Teachers College in Oklahoma, he received a commission from the Officers Candidate School, Newport, RI, in July 1965 as an ensign in the Supply Corps, U.S. Navy.

Following commissioning, he attended the Navy Supply Corps School in Athens, GA. His first duty station was at the Naval Ammunition Depot, Hawthorne, NV, where he served as the disbursing and accounting officer until July 1968. His next two years were spent out of Naval service. Vincent was an accountant for North American Rockwell and an account manager for Investors Diversified Services, both in Tulsa, OK.

Admiral Vincent returned to the Navy in 1970 and was assigned as a supply officer with the Naval Special Warfare Group in Little Creek, VA. In October 1971, he was assigned as the first supply officer in the newly established Naval Inshore Warfare Command, Atlantic.

In October 1972, he reported to the USS PENSACOLA as a supply officer. Two years later, he attended the Armed Forces Staff College, Norfolk, VA. He then earned a master's in business administration from George Washington University in August 1976.

Upon completion of his degree, Admiral Vincent served as director of the contracting department at the Naval Supply Center Puget Sound until July 1979. From August 1979 to June 1982, he was a contracting officer for the FFG construction program and surface ship overhauls as the Supervisor of Shipbuilding and Repair, Bath, ME.

He returned to sea duty in July 1982 as supply officer in the submarine tender USS Dixon (AS-37), with additional duty as staff supply officer for the commander, Submarine Squadron Three. In August 1984, he became the director of the combat systems department of the Navy Ships Parts Control Center, Mechanicsburg, PA. In August 1986, he was reassigned as the director of contracting.

In July 1989, Admiral Vincent assumed command of the then Defense Contract Administration Services Region Los Angeles, an activity of DLA. From July until October 1990, he was the special assistant to the commander of the Defense Contract Management Command in Alexandria, VA. In 1990, he became commander of the Defense Contract Management Command International in Dayton, OH, and from September 1991 to November 1992, he was assigned as the assistant commander for contracts at the Naval Air Systems Command, Washington, D.C.

DEBORAH L. WINCE-SMITH

Senior Fellow
Council on Competitiveness

Deborah L. Wince-Smith, the first assistant secretary for technology policy in the U.S. Department of Commerce under President George Bush, has joined the Council on Competitiveness as a senior fellow. The Council on Competitiveness is a private, non-profit coalition of chief executives from leading businesses, organized labor, and academia whose mission is to improve the competitiveness of U.S. industry and its workers in an international marketplace in a way that builds a rising standard of living at home.

Assistant Secretary Wince-Smith served as the principal officer in the Commerce Department for developing, coordinating, and advocating policies to increase the role of technology in enhancing the competitiveness and economic well-being of the United States. She led three operating units which constitute the Office of the Assistant Secretary for Technology Policy (OASTP), an agency within the Technology Administration. They are: the Office of Technology Policy Analyses and Studies, the Office of International Technology Policy and Programs, and the Office of Technology Commercialization. These offices act as catalysts and help to build new and innovative alliances among industry, government, and academia to meet the challenge of developing new technologies and bringing them to the global marketplace.

OASTP complements U.S. industry's efforts to deploy technology by advocating Federal policies and programs that support industry's ability to commercialize technology. It also works with U.S. industry to encourage the commercial use of Federal R&D, and the adoption of modern manufacturing technologies and methods. A new and innovative program, the Strategic Partnerships Initiative, promotes multi-firm and inter-industry cooperation to reduce cost and risk in the development and commercialization of enabling technologies.

OASTP advocates international science and technology policies that promote U.S. competitiveness. Key responsibilities include increasing industry's access to foreign technologies and protecting U.S. intellectual property rights and commercial interests in international R&D cooperation. OASTP also coordinates the U.S. response to proposed international research programs such as the Intelligent Manufacturing Systems initiative put forth by Japan.

Prior to joining the Technology Administration, Ms. Wince-Smith served from 1984-1989 as Assistant Director for International Affairs and Global Competitiveness in the White House Office of Science and Technology Policy. She was actively involved in developing and implementing Presidential international science and technology policies and programs, and the design of Presidential initiatives in superconductivity, technological competitiveness, and Head of Government Science and Technology Agreements. As a National Science Foundation program manager from 1976-1984, she was responsible for managing bilateral research activities between U.S. scientists and engineers and their counterparts in Eastern Europe.

Ms. Wince-Smith received her Master's Degree from Cambridge University in 1974, and graduated Phi Beta Kappa and Magna Cum Laude from Vassar College in 1972.

A native of Akron, OH, Ms. Wince-Smith currently resides in McLean, VA with her husband, Ambassador Michael B. Smith, and their two sons.

EVALUATION FORM
1993 ACQUISITION RESEARCH SYMPOSIUM

5 = Excellent 4 = Good 3 = Satisfactory 2 = Fair 1 = Poor

By using the above rating scale, please indicate your evaluation of the 1993 Symposium. Your responses will help us to tailor the 1995 Symposium.

1. What is your overall evaluation of the Symposium? 5 4 3 2 1

   Comment:____

____

	5	4	3	2	1
Hotel Location	5	4	3	2	1
Comment____________________					
Parking	5	4	3	2	1
Comment____________________					
Symposium Schedule (time of year)	5	4	3	2	1
Comment____________________					
Symposium Schedule (daily starting time)	5	4	3	2	1
Comment____________________					
Symposium Proceedings	5	4	3	2	1
Comment____________________					
Registration Process	5	4	3	2	1
Comment____________________					
Administrative Management Throughout Symposium	5	4	3	2	1
Comment____________________					
Session Presentation Process	5	4	3	2	1
Comment____________________					
Session Scheduling Method	5	4	3	2	1
Comment____________________					
Session Length	5	4	3	2	1
Comment____________________					

Session Moderators	5	4	3	2	1

Comment____

Keynote Address (James McDivitt)	5	4	3	2	1

Comment____

Panel Presentations	5	4	3	2	1

Comment____

____

Facilities (lunch/breaks, reception)	5	4	3	2	1

Comment____

____

3. Which Guest Speaker(s), listed below, did you find noteworthy?

   Steven K. Conver   Deborah Wince-Smith   William L. Vincent

   Comment____

   ____

   ____

4. What session topic(s) would you rate as particularly noteworthy? (Please List)

____

____

5. What session topic(s) would you like to be presented at the next Symposium? (Please List) ____

____

6. May we contact you to be a presenter at the next Symposium?

_____Yes, please contact me at:	____No, I recommend that you contact:
(Name)	(Name)
(Address)	(Address)
(Telephone)	(Telephone)

CONTINUING EDUCATION UNITS

Application Form

Name & Title ______________________________

Firm or Agency ______________________________

Address ______________________________

City ______________________________ State ________ Zip ______

Telephone (_______)__________________________

NCMA Member Number ______________________ Chapter ________________

Social Security Number (if Member Number not available) ____________________

For non-members, would you like to receive membership information? _____

Do you wish to receive a CEU certificate? ____ Credits will be recorded regardless of whether you receive a certificate. If you wish a certificate mailed to an address other than the one listed above, please complete the section below:

Address ______________________________

City ______________________ State ______________________ Zip ____________

I CERTIFY THAT I ATTENDED THE ENTIRE SEMINAR LISTED BELOW IN ORDER TO QUALIFY FOR THE CONTINUING EDUCATION UNITS BEING AWARDED.

______________________________ ______________________________

(Signature) (Date)

************************************** **

Seminar Information

Location: Rockville, Maryland Date: June 22-24, 1993

Title: 1993 Acquisition Research Symposium

I CERTIFY THAT THE ABOVE-NAMED PERSON ATTENDED THE ENTIRE SEMINAR LISTED ABOVE.

______________________________ ________________ ________________

(Signature of Chapter Official) (Title) (Date)

************************************** **

FOR OFFICE USE ONLY: ID #____________ CEU Points _____________ Date______________

Mail to: NCMA, 1912 Woodford Road, Vienna, VA 22182 (803) 448-9231

1993 ACQUISITION RESEARCH SYMPOSIUM PROCEEDINGS

Order Blank

To order an additional copy of the 1993 ACQUISITION RESEARCH SYMPOSIUM PROCEEDINGS, please complete the order blank below, and mail to:

Acquisition Research Symposium
National Contract Management Association
1912 Woodford Road
Vienna, Virginia 22182

Number of Copies ______________________ at $30 per copy (check/money order enclosed, payable to NATIONAL CONTRACT MANAGEMENT ASSOCIATION).

____

(Name)

____

(Street Address)

____

(City, State, Zip Code)

Office Telephone # ______________

NATIONAL CONTRACT MANAGEMENT ASSOCIATION

WASHINGTON, D.C. CHAPTER

1993 ACQUISITION RESEARCH SYMPOSIUM

This is to certify that ______________________________

attended the 1993 Acquisition Research Symposium held in Rockville, MD. Attendance at the Symposium provides twenty hours towards CPCM/CACM Recertification.

Donna S. Ireton, Symposium Co-Chair

W. Gregor Macfarlan, CPCM
National President

HOLIDAY INN CROWNE PLAZA